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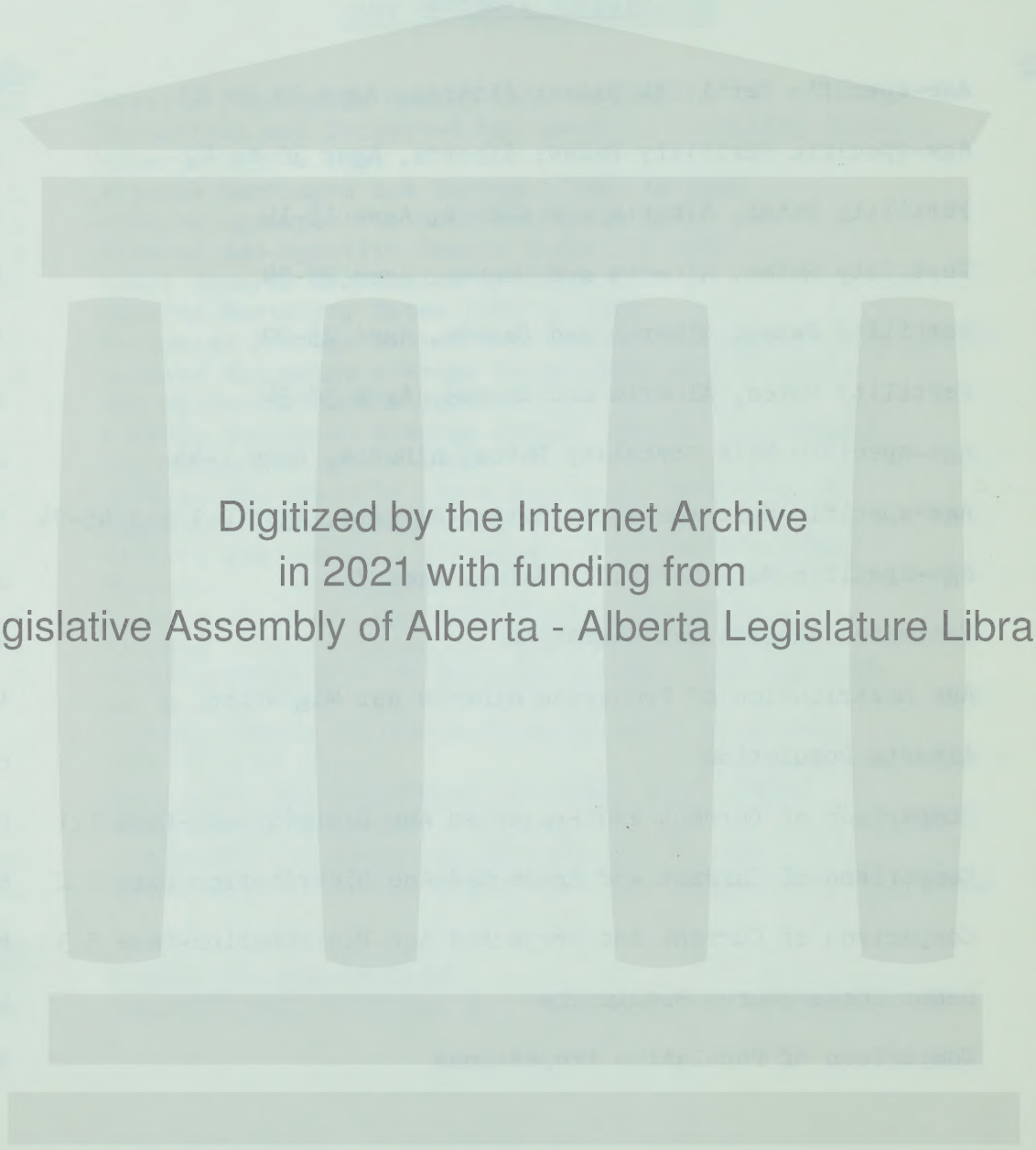

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1. Introduction

1.1 This study of Alberta population was undertaken by the Economic Studies Department of the Oil and Gas Conservation Board in the summer of 1968. The Board employs population forecasts particularly in its assessment of the long term requirements for natural gas and propane in Alberta.

1.2 The current study is distinguished from the Board's previous population forecasts by the employment of computer programmes, both to project population by extrapolation of the structural parameters involved and to analyze historical migration for the Province. The programmes are general in form and may be readily applied to assumptions which differ from those adopted in this report. As such, it is anticipated that the updating of the current projections to reflect new data and changing circumstances will be a relatively rapid process.

1.3 For purposes of reference, the sources of data and information have been listed at the end of the Sections to which they relate. In addition, a compilation is provided in Appendix C.

2. Historical Review

2.1 A summary of Alberta population growth in relation to Canada is shown in Table 2.1. Alberta first became an area of significant population within Canada in the early part of the twentieth century. The establishment of the prairie wheat economy induced a significant inflow of settlers both from abroad and from eastern Canada. Alberta's population growth from a level of 73,000 in 1901 to 588,000 in 1921 increased the Province's share of Canada's population from 1.4 to 6.7 per cent. During the period 1921 - 1931, Alberta's average rate of growth in population surpassed that of Saskatchewan and became the highest in Canada after British Columbia. (1, p. 14)

2.2 The depression of the thirties brought an end to this expansion; agriculture suffered severely and recovered slowly. Being almost totally dependent on agriculture, the prairies were seriously depressed by the world-wide decline in demand for agricultural products, concomitant with the breakdown of international trade. At its lowest level in 1933, Alberta's total personal income was almost 60 per cent below its 1927 high. (1, p. 134) Alberta suffered both a net outflow of population and a decline in fertility rates. (1, p. 21 & 38) As a result, the population remained almost static during the decade 1931 - 1941 and showed little change during the first half of the forties when the war effort redistributed population towards centres of industrial production and military activity. Hanson estimates that Alberta lost 53,000 of a natural increase* of some 60,000 during 1941 - 1946. (2, p. 281) After the war, the previous stagnation began to be offset by the post-war 'baby boom'. Net family formation was stimulated by the

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* The excess of births over deaths.

return of ex-servicemen and the prosperity ensuing from the industrial expansion required to satisfy the accumulated demand for consumer goods.

2.3 Significant population expansion resumed for both Canada and Alberta in the later forties and in the fifties. While Canada's average annual rate of natural increase rose to 2.0 per cent during 1951 - 1960, Alberta's went even higher to 2.5 per cent. This increase, combined with a net average annual immigration rate of 1.3 per cent (3, p. 22), resulted in Alberta enjoying the fastest rate of growth of population in Canada.

2.4 Alberta owed this distinction primarily to the growth of the petroleum industry, which augmented and stabilized the economy. By 1956, some 30 per cent of Alberta's income was derived directly from this industry. (2, p. 293) Without this development, Hanson estimates that the population would have remained at its 1946 level (2, p. 282) and would perhaps have eventually fallen with the mechanization and consolidation of farms - which has resulted in a continuing decline in farm population from 339,000 in 1951 to 278,000 in 1966 (4 & 5, Table 13) - without any compensating increase in alternative employment. The development of the petroleum industry offered opportunities for the employment of skilled and educated personnel, and had important secondary and tertiary effects on economic activity.

2.5 The outstanding feature of the post-war population increase in Alberta is that it has been centred predominantly in urban areas. From 1946 to 1956 the population of urban centres* more than doubled, while the rest of the Province increased by only 3 per cent in the decade. (2, p. 284) By 1966, 69 per cent of Albertans lived in urban areas while only 19 per cent were farm residents. (4, Table 13) The mechanization of agriculture

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* Designated as those with over 1,000 residents.

has increased the size and decreased the number of farms. The exodus from the farm has been encouraged by an apparently widening gap between farm and non-farm income opportunities. The fact that Canadian domestic demand for farm products is relatively unresponsive to changes in either price or income, particularly at high levels of prosperity, has prevented agriculture from participating in boom conditions to the same extent as other activities. However, grain has benefited from the expansion of international markets after 1960. (1, p. 363-7)

2.6 Alberta's urbanization reflects the Canadian trend. In the first 65 years of the twentieth century, urban dwellers have increased from 35 to 74 per cent of the Canadian population, while those on farms have dwindled from 33 to 10 per cent. (3, Tables A2 and A3)

2.7 The early 1960's have been characterized by a slackening in both Canadian and Alberta population growth rates relative to that experienced in the 1950's. This is due in part to urbanization, with its associated lower fertility rates, and also reflects a lower level of net immigration. Fertility rates declined by 18 per cent in Canada during the first half of the 1960's. The 1965 Canadian net reproduction rate* of 3.192 compares with 3.895 in 1960 and 3.357 in 1926. This decline has more than offset recent increases in the number of women of child-bearing age. As shown in Table 4.2, total births have actually fallen while marriages have increased. Contributing factors are the relatively high cost of urban family living space, increasing female participation in the labor force and the development of more efficient methods of birth control.

2.8 The large volume of Canadian immigration during the mid-fifties

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* Net reproduction rate is the average number of children born to a woman in her life-time.

was due to circumstances which were substantially non-recurring in nature.** By 1963, net immigration to Canada was virtually nil. The subsequent years have seen a new upsurge in Canadian net immigration to reach a level of 90,000 in 1966. (8, p. 21) However, as shown in Section 6 of this study, the impact of this on Alberta population apparently has not been as great as in the 1950's.

2.9 In summary, the history of Alberta's population has been one of rapid growth interrupted only by the depression and the war. Since 1946, this growth has been largely attributable - indirectly and directly - to the expansion of the petroleum industry. Moreover, it has been predominantly urban as population patterns have shifted in response to changing economic opportunities.

References

(1) Urquhart & Buckley, Historical Statistics of Canada. (1965).

(2) Hanson, E.J., Dynamic Decade. (1958).

(3) E.C.C. Staff Study #13, 'Internal Migration in Canada, 1921-1961'. (March 1966).

(4) D.B.S. 1966 Census. Cat. No. 92-608.

(5) D.B.S. 1961 Census. Cat. No. 92-536.

(6) D.B.S., Vital Statistics, 1965. (July 1967).

(7) Canadian Statistical Review (Periodical) - Annual issues for 1963-1966.

(8) E.C.C. Staff Study #19, 'Population, Family, Household and Labour Force Growth to 1980'. (September 1967)

** See par. 6.6 for details.

Table 2.1

Alberta Population Growth
1901 to 1966

Year	Alberta Population	AAGR* (Interval) %	Canadian Population	AAGR* (Interval) %	Alberta Population as Proportion of Canadian Population %
1901	73,022		5,371,315		1.4
		17.8		3.0	
1911	374,295		7,206,643		5.2
		4.6		2.0	
1921	588,454		8,787,949		6.7
		2.2		1.7	
1931	731,605		10,376,786		7.1
		0.9		1.0	
1941	796,169		11,506,655		6.9
		1.7		2.0	
1951	939,501		14,009,429		6.7
		3.6		2.7	
1961	1,331,944		18,238,247		7.3
		1.9		1.9	
1966	1,463,203		20,014,880		7.3

Source: E.C.C. Staff Study #13, Table A1.
1966 Census (DBS Cat. No. 92-608), Table 13.

* AAGR = Average Annual Growth Rate.

3. Population Parameters and Projection Method*

3.1 Given the sex and age structure of an original population, the determinants of a future population are fertility, mortality, immigration and emigration. These variables reflect social and economic influences such as the level of industrialization, the standard of living, urbanization, education, health and welfare services. Detailed consideration to trends in fertility, mortality and migration is given in Sections 4, 5 and 6, respectively, of this study.

3.2 Given assumptions concerning the variables, future population can be extrapolated via the component method. (1, p. 6 ff.) The procedure is as follows:

1. Commence with a base population having a given sex and age distribution.
2. Estimate survivors by applying appropriate death rates to each sex and age-specific group.
3. Add births by applying age-specific fertility rates to each female group of child-bearing age.
4. Add immigrants to their appropriate age and sex groups and subtract emigrants.
5. Repeat steps 1-4 to estimate the population and its age and sex distribution for successive intervals of time.

3.3 If the death and fertility rates and the distribution of migration were fixed, a long-run steady-state distribution could be determined which would be reached independently of the initial distribution. (2)

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* The population projection model is discussed in detail in Appendix A.

However, the precise future values of the population parameters are neither known nor likely to be fixed. Rather, estimates of the future levels of the population parameters will be based on an examination of past trends and anticipated variations in relevant underlying factors.

3.4 Consideration of past trends for fertility and migration, discussed in Sections 4 and 6, reveals considerable fluctuation. To provide a range of future projections embracing the potential degree of variation, three trends - high, medium and low - were estimated for both fertility and migration. In contrast, only one set of estimates was made of death rates, which exhibit relative stability, as shown in Section 5. The impact of any future fluctuation in death rates is comparatively unimportant, since this parameter is less significant than fertility and migration.*

3.5 The adoption of three sets of fertility rates, one set of death rates, and three estimates of migration yields nine different projection cases. These nine combinations of parameters were applied to the 1966 census population to obtain population projections to 1996.

References

(1) E.C.C. Staff Study #19, 'Population, Family, Household and Labour Force Growth to 1980'. (September 1967).

(2) Lewis, E.G., On Generation and Growth of a Population, Sankhya, Vol. 6, 1942.

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* For details see par. 7.8.

4. Analysis of Fertility Rates

Historical Trends

4.1 The long run trend in crude birth rates* for most industrialized nations seems to be a gradual secular decline. Malthusian predictions of a population kept perpetually at subsistence level by its fecundity in response to rises in real income have yet to be realized in the developed countries. Increases in age-specific fertility rates** which may normally result from rising per capita income appear to have been more than offset by the countervailing influences of education and urbanization. (1, pp. 314-339) Table 4.1 and Figures 4.1 and 4.2 show the historical pattern of age-specific Alberta fertility rates.

4.2 In Alberta, recent experience has been dominated by depression and war. Drastic fertility rate declines reflected the despair of the 1930's; war disrupted the early forties. The 'baby boom' over the 15 years prior to 1960, although an upturn of significant magnitude and duration, was again the product of the unique circumstances discussed in paragraph 2.2. These disturbances tend to obscure any long-run 'normal' trends. As such, historical trends do not provide firm evidence for predicting fertility rates or for ascertaining with any precision the impact of increasing income, education and urbanization.

4.3 Total births are a function of age-specific fertility rates and the age structure of the female population. The commonly-used crude birth rate tends to obscure the influence of these two determinants. Analysis

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* Crude birth rate (per 1,000) = $\frac{\text{annual total live births}}{\text{mid-year population}} \times 1000.$

** Age-specific fertility rate (per 1,000) = $\frac{\text{annual births to women in a given age group}}{\text{number of women in the age group at mid-year}} \times 1000.$

of births by the component method - that is, by applying age-specific fertility rates - permits the observation of a distinction between the impact of changes in age structure and in fertility rates. This distinction is of particular relevance when the two factors may be working in opposite directions.

4.4 Since 1960, declining fertility rates - as exhibited in Table 4.1 - have offset increases in the number of women occupying the most fertile age groups. (4, Table 19) Table 4.2 shows that although annual marriages in Alberta rose 13.3 per cent from 1960 to 1966, total annual births fell 21.6 per cent in the same period. The contrast is mitigated to the extent that the relationship between births and marriages is lagged. However, both the average and median ages of brides wed for the first time during this period in Alberta fell within the most fertile age group (20-24). (2, Table M3) The Canadian figures accentuate the disparity: a 19.3 per cent increase in marriages and a 19.1 per cent decline in total births for 1960 - 1966. (2, Tables M1 & M3)

4.5 The fluctuations in age-specific fertility rates in Alberta over the past 25 years have reflected changes in marriage and family patterns as well as economic opportunity. The average bride and mother has become younger. After World War II, the age group 20-24 replaced 25-29 as the most fertile; by 1961 the group 15-19 had replaced 35-39 as fourth most fertile. The fertility rates for women 15-34 rose substantially, while they declined for those 35-49. All rates began declining about 1960, with the exception of the 20-24 group, which continued to rise till 1962. By 1965, rates for all women over 25 were below their 1931 levels.

4.6 Figures 4.3 to 4.6, inclusive, depict a comparison between Alberta's and Canada's fertility rates for the four most fertile age groups: 15-19, 20-24, 25-29, 30-34. Alberta's rates have been clearly above Canada's for the first three age groups, and about the same for the fourth. In recent

years the differential has narrowed substantially for the 20-24 group; it has been virtually eliminated for the 25-29 group.

Projections

4.7 For the projections to 1981, the Economic Council of Canada's practice of using three future trends - high, medium and low - for fertility rates was adopted. (3, Table 2-5) This procedure was justified in view of the evident difficulty of extrapolating a parameter such as fertility, which is subject to many influences and has displayed an erratic historical pattern. The high trend assumes that fertility rates are subject to cyclical influences: fertility rates are projected at constant levels to 1971 and then are assumed to rise to approximately the 1964 level by 1981. The medium trend assumes that the present rates of decline in fertility will level off by 1971 and decrease only marginally thereafter to 1981. The low trend assumes a steeper decline than the medium case, although still less sharp than the slope apparent from recent historical trends; statistical extrapolation of the 1956 - 1966 data yielded lower final results for ages 25-49 by 1981. Extrapolation of the estimated 1961 - 1966 slope would have yielded rates of zero for ages 20-39 by 1981. Consequently, even the low case must logically assume that the recent rate of decline in fertility levels will be arrested at some point in the future. Overall, it does appear probable that current fertility rates will decline further as birth control continues to become both easier and more popular and as urbanization progressively extends.

4.8 Details of the three projections are shown in Table 4.1 and Figures 4.1 and 4.2 for each five-year age group. Figures 4.3 to 4.6 compare for the four most fertile age groups the Economic Council of Canada's projections of Canadian rates with the projections adopted in this study. (3, Table 2-4) Figure 4.3 indicates that Alberta's fertility rates for the fourth most fertile

age group (15-19) have been consistently higher than the Canadian average and are presumed to remain so in the future. Figures 4.4 to 4.6 indicate that for the three most fertile age groups - ages 20 to 34 - Alberta's fertility rates in the low and medium cases compare closely in slope and magnitude to the corresponding Canadian cases. In contrast, the slope and magnitude of Alberta's high case becomes much greater than the corresponding Canadian case as time progresses.

4.9 Under all cases the extrapolation of fertility rates beyond 1981 assumes that the rates will remain constant at their projected 1981 levels. This procedure was based on the belief that continuation of postulated trend slopes after 1981 would be of doubtful validity.

4.10 The distribution of births by sex was based on the relationship between the average number of live male births per 1,000 live female births experienced during the period 1956 to 1966. Alberta's arithmetic average (2, Table B2) of 1,054 male births per 1,000 live female births for this period was adopted in the predictions in absence of any statistically significant trend over this period.* This ratio was projected as a constant for the entire forecast period, 1966 to 1996.

References

(1) Adelman, I., 'An Econometric Analysis of Population Growth', American Economic Review, V. 53, No. 3, (June 1963).

(2) D.B.S. 'Vital Statistics' - 1965 and 1966. Cat. No. 84-202. (July, 1967 and September, 1968).

(3) E.C.C. Staff Study #19, 'Population, Family, Household and Labour Force Growth to 1980'. (September 1967).

(4) D.B.S. 1966 Census. Cat. No. 92-610. (March, 1968).

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* A linear trend fitted to 1956 - 1966 data gave a correlation coefficient (r) of only 0.095.

TABLE 4.1

HISTORICAL AND PROJECTED AGE-SPECIFIC FERTILITY RATES:
ALBERTA 1931 - 1996
(ANNUAL LIVE BIRTHS PER 1000 WOMEN IN AGE GROUP)

YEARS	AGE GROUPS						
	15-19	20-24	25-29	30-34	35-39	40-44	45-49
				HISTORICAL*			
1931	36.0	164.5	189.4	142.5	96.9	40.8	5.2
1941	31.9	150.2	162.6	114.6	74.3	29.3	3.6
1951	55.9	220.5	207.8	143.7	84.6	28.9	2.9
1956	73.7	264.0	243.3	155.0	87.1	30.3	2.9
1961	84.5	278.4	231.6	148.3	81.2	27.4	1.9
1962	82.1	280.2	225.6	143.1	75.8	27.3	2.1
1963	79.3	272.4	219.5	141.0	76.2	25.8	1.9
1964	70.3	256.0	206.7	133.8	68.2	25.6	1.8
1965	66.4	222.9	186.5	119.2	63.8	22.0	2.2
1966	65.0	196.7	168.6	103.9	58.4	19.0	1.7
				PROJECTED			
HIGH							
1971	65	197	169	104	58	19	1.7
1976	68	223	184	119	63	23	1.8
1981	70	250	200	135	68	26	1.9
1996	70	250	200	135	68	26	1.9
MEDIUM							
1971	61	177	150	94	52	17	1.5
1976	58	174	148	93	50	16	1.5
1981	55	171	145	91	48	15	1.5
1996	55	171	145	91	48	15	1.5
LOW							
1971	55	164	140	88	48	15	1.5
1976	50	149	126	81	43	14	1.4
1981	45	133	112	73	38	12	1.3
1996	45	133	112	73	38	12	1.3
REGRESSION ESTIMATES (BASED ON 1956 TO 1966 DATA)							
1981	51	160	95	62	20	11	0
r^2	0.37	0.43	0.78	0.74	0.89	0.71	0.60
SLOPE COEFFICIENT, b	-1.39	-5.29	-6.71	-4.18	-3.06	-0.80	-0.11
t-SCORE	2.29	2.61	5.57	5.04	8.77	4.72	3.65

(ALL t-SCORES ARE SIGNIFICANT: THE CRITICAL 95% CONFIDENCE LEVEL IS 2.26, WITH n-2 OR 9 DEGREES OF FREEDOM.)

* SOURCE: D.B.S. VITAL STATISTICS, TABLE B6.

Table 4.2

Alberta Marriages and Births:
1960 to 1965

Year	Number of Marriages	% Change*	Number of Births	% Change*
1960	10,482		39,009	
1961	10,474	- 0.1	38,914	- .2
1962	10,423	- 0.5	38,804	- .2
1963	10,163	- 2.5	38,467	- .9
1964	10,634	+ 4.6	36,169	- 6.0
1965	11,209	+ 5.4	32,664	-10.8
1966	11,879	+ 5.9	30,592	- 6.3
1960 - 1966		+13.3		-21.6
Canada 1960 - 1966		+19.3		-19.1

Source: D.B.S. Vital Statistics, Tables M1, B1.

* Change as a percentage of previous year's figure.

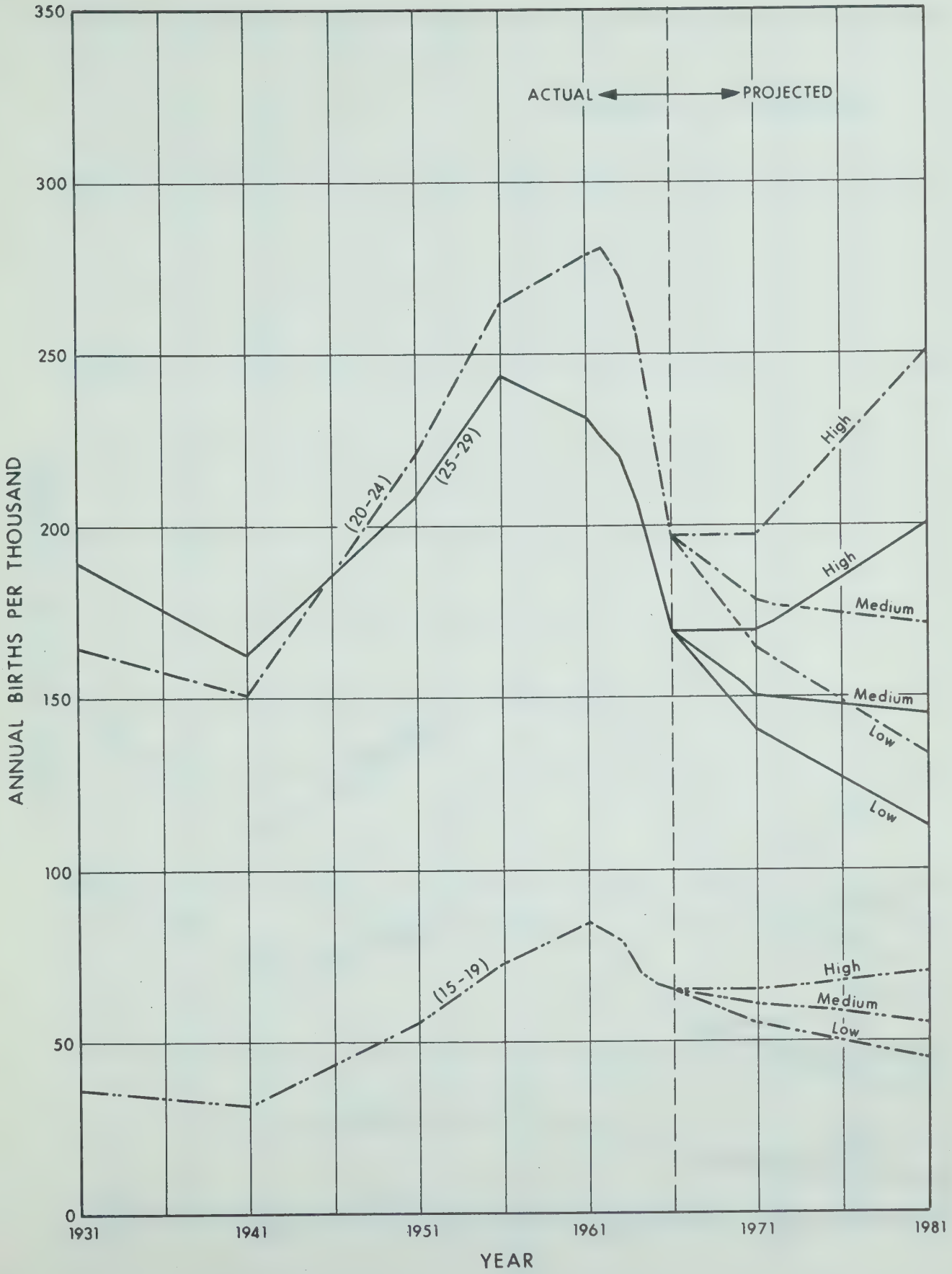
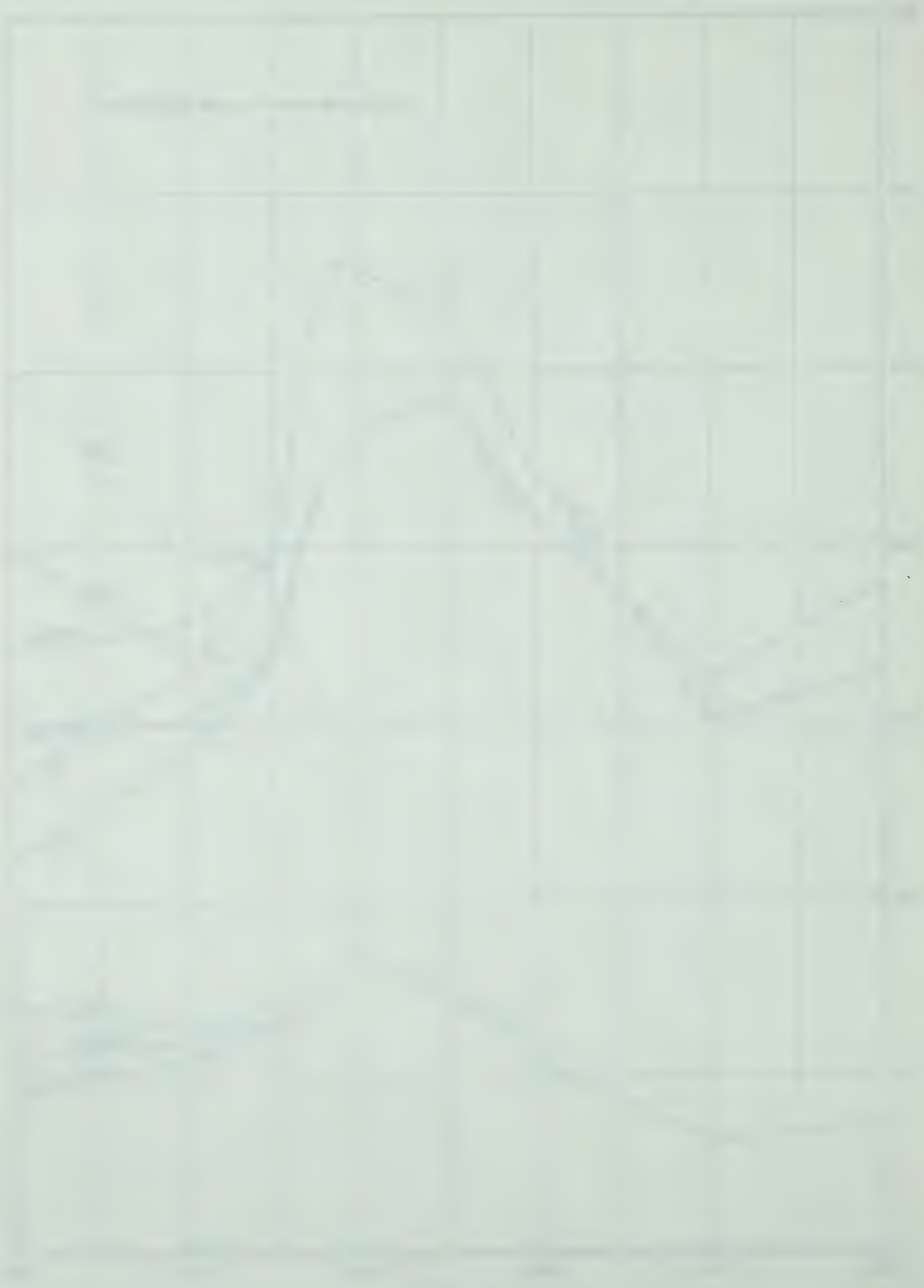


FIGURE 4.1 AGE - SPECIFIC FERTILITY RATES; ALBERTA, AGES 15 TO 29

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA



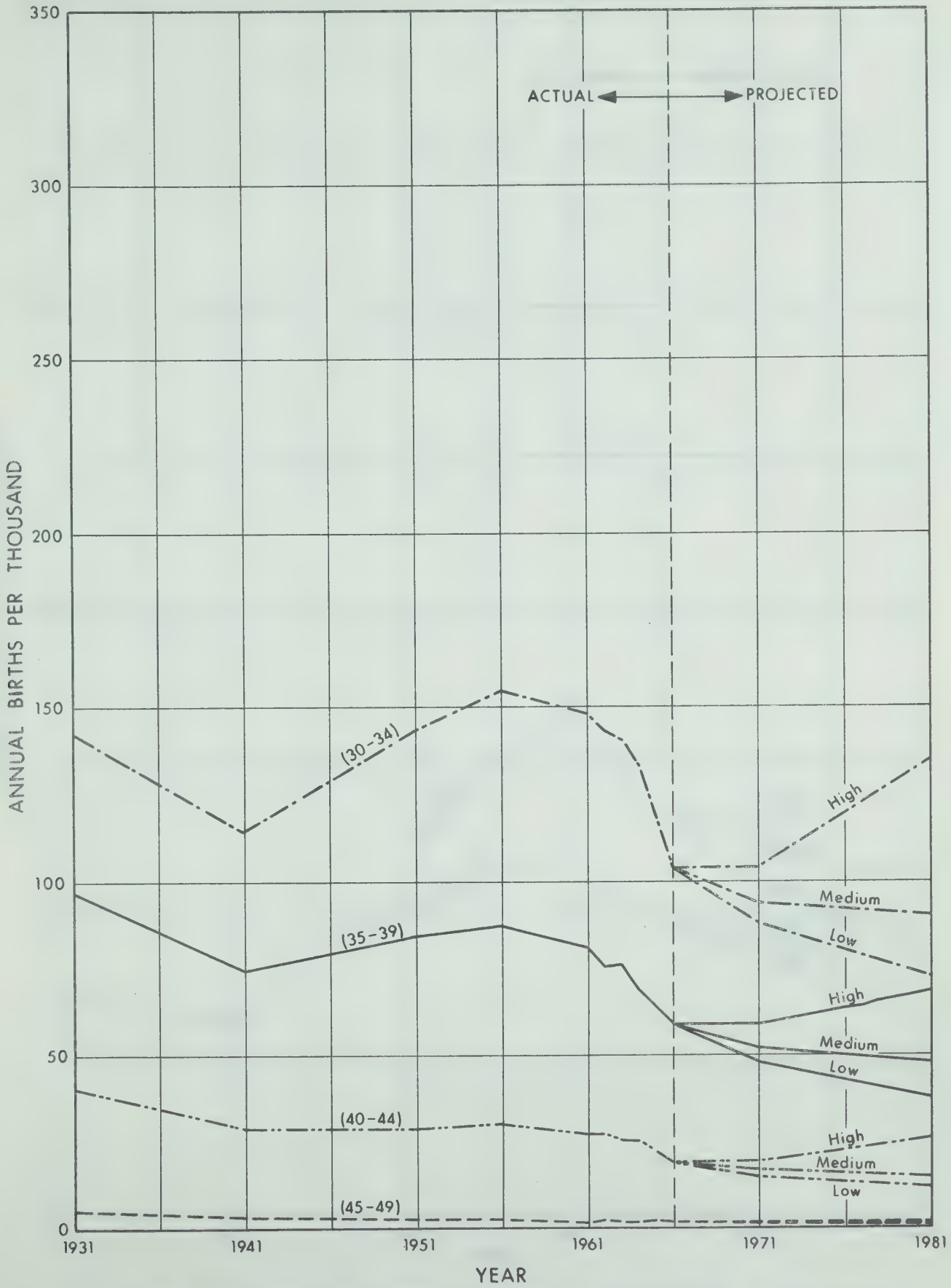


FIGURE 4.2 AGE-SPECIFIC FERTILITY RATES; ALBERTA, AGES 30 TO 49

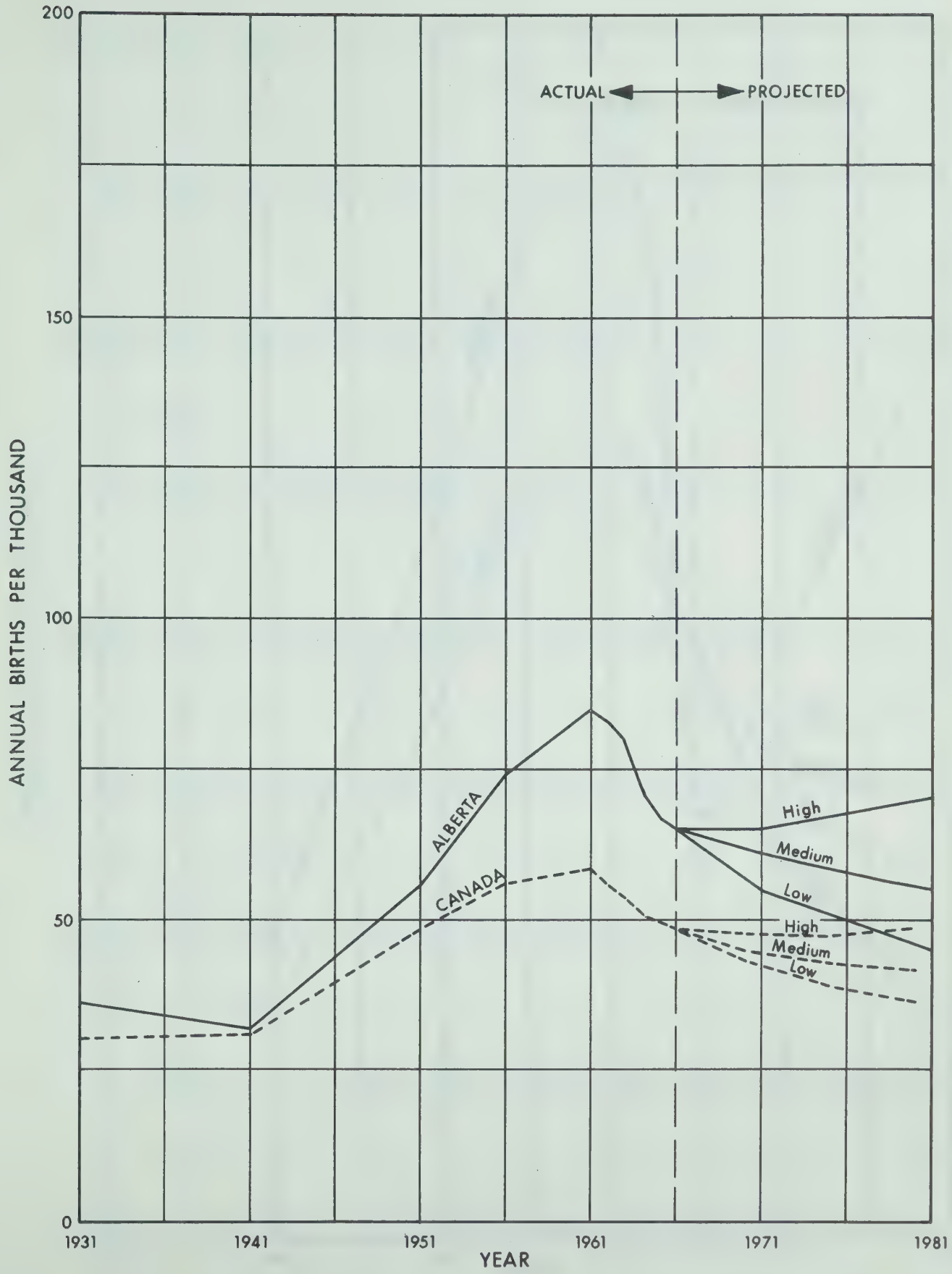
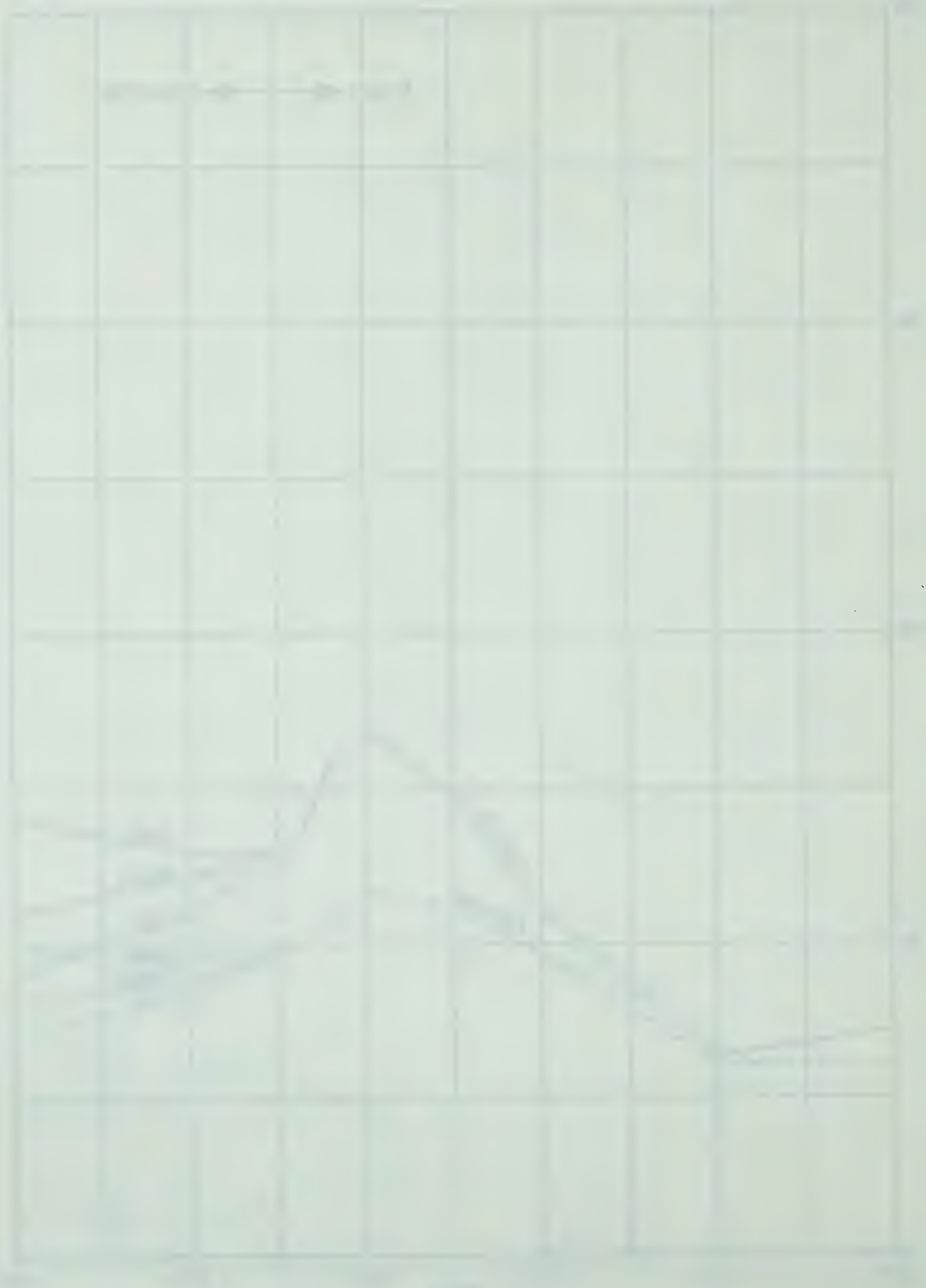


FIGURE 4.3 FERTILITY RATES, ALBERTA and CANADA, AGES 15-19



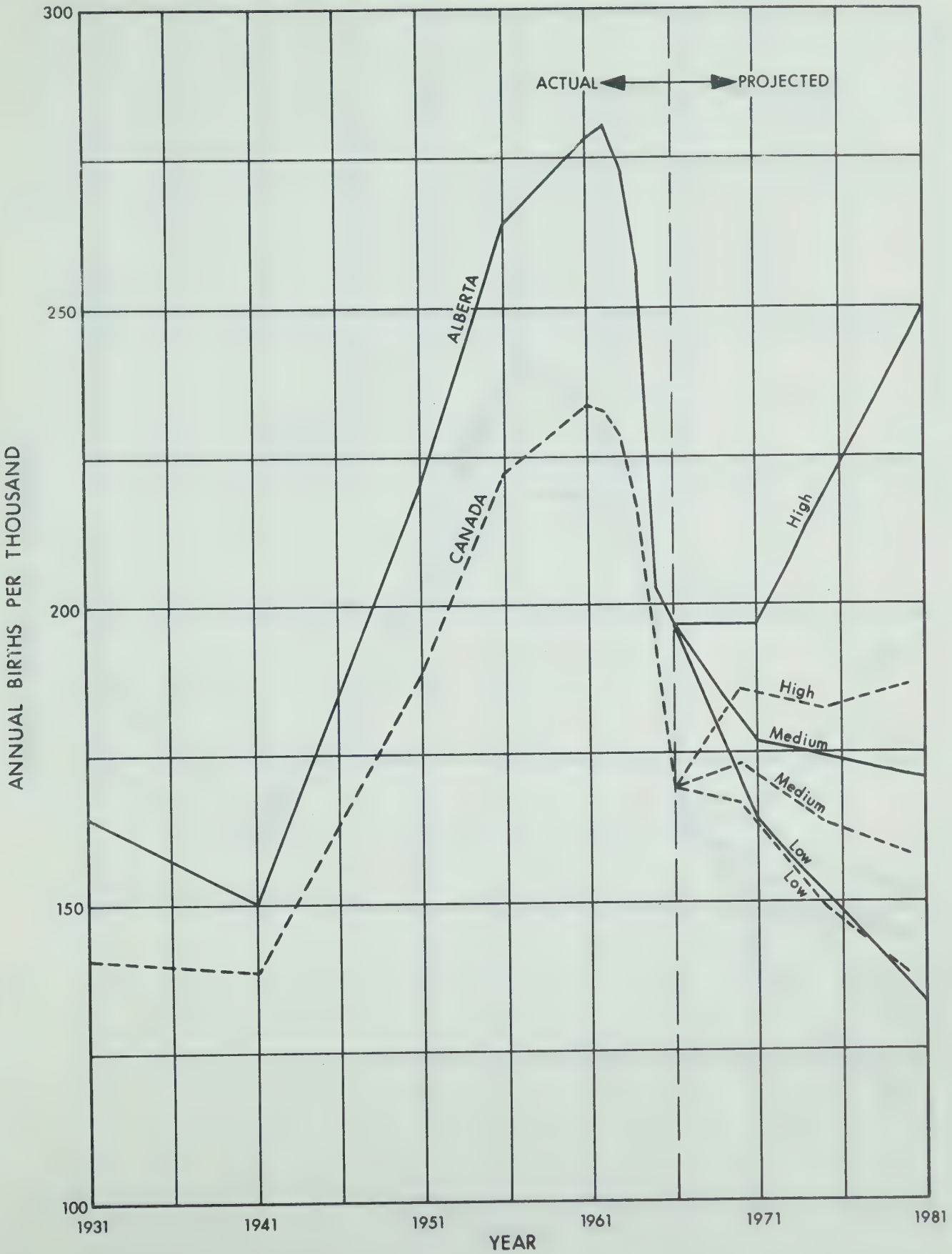


FIGURE 4.4 FERTILITY RATES, ALBERTA and CANADA, AGES 20-24

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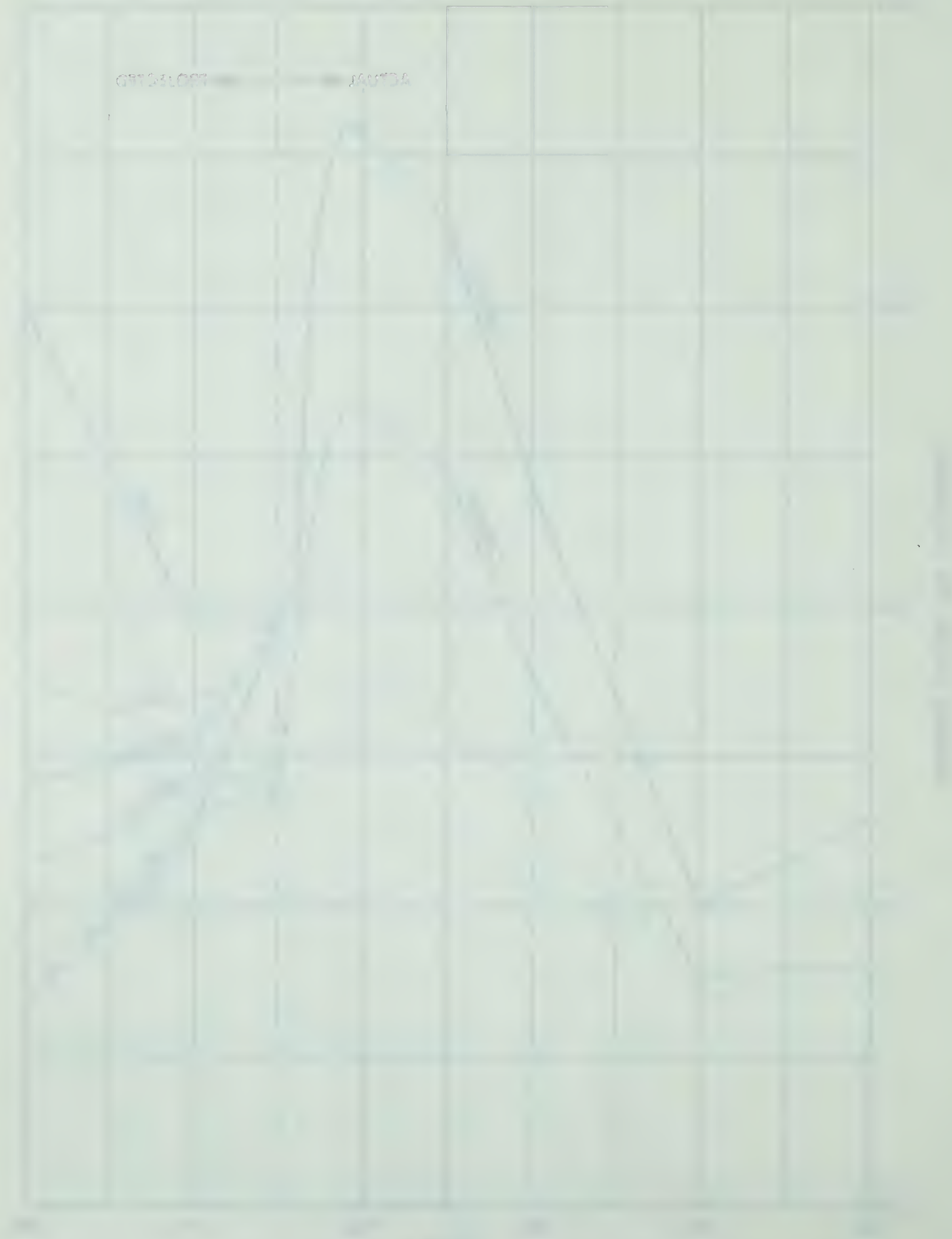
CALGARY, ALBERTA



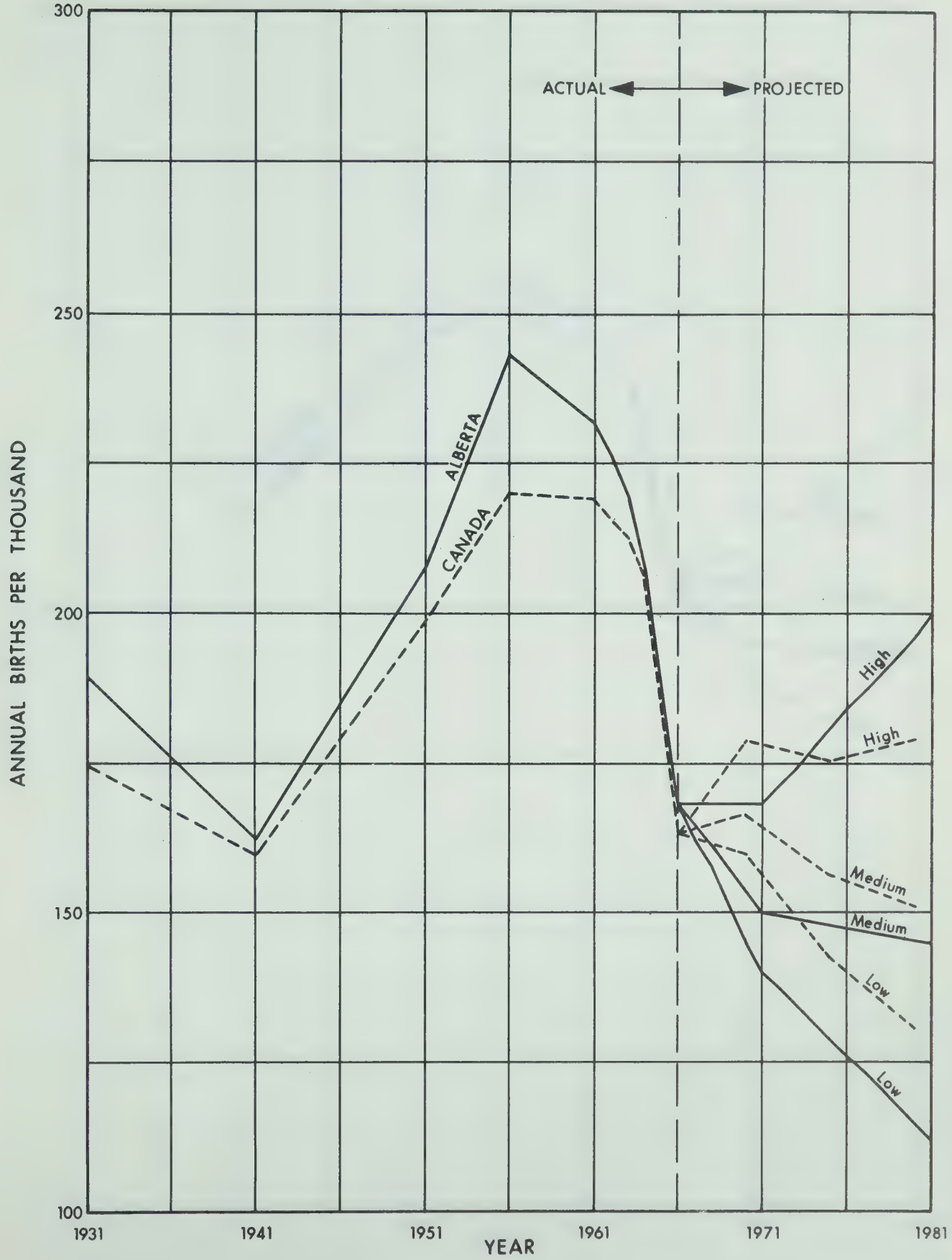


FIGURE 4.5 FERTILITY RATES, ALBERTA and CANADA, AGES 25-29

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

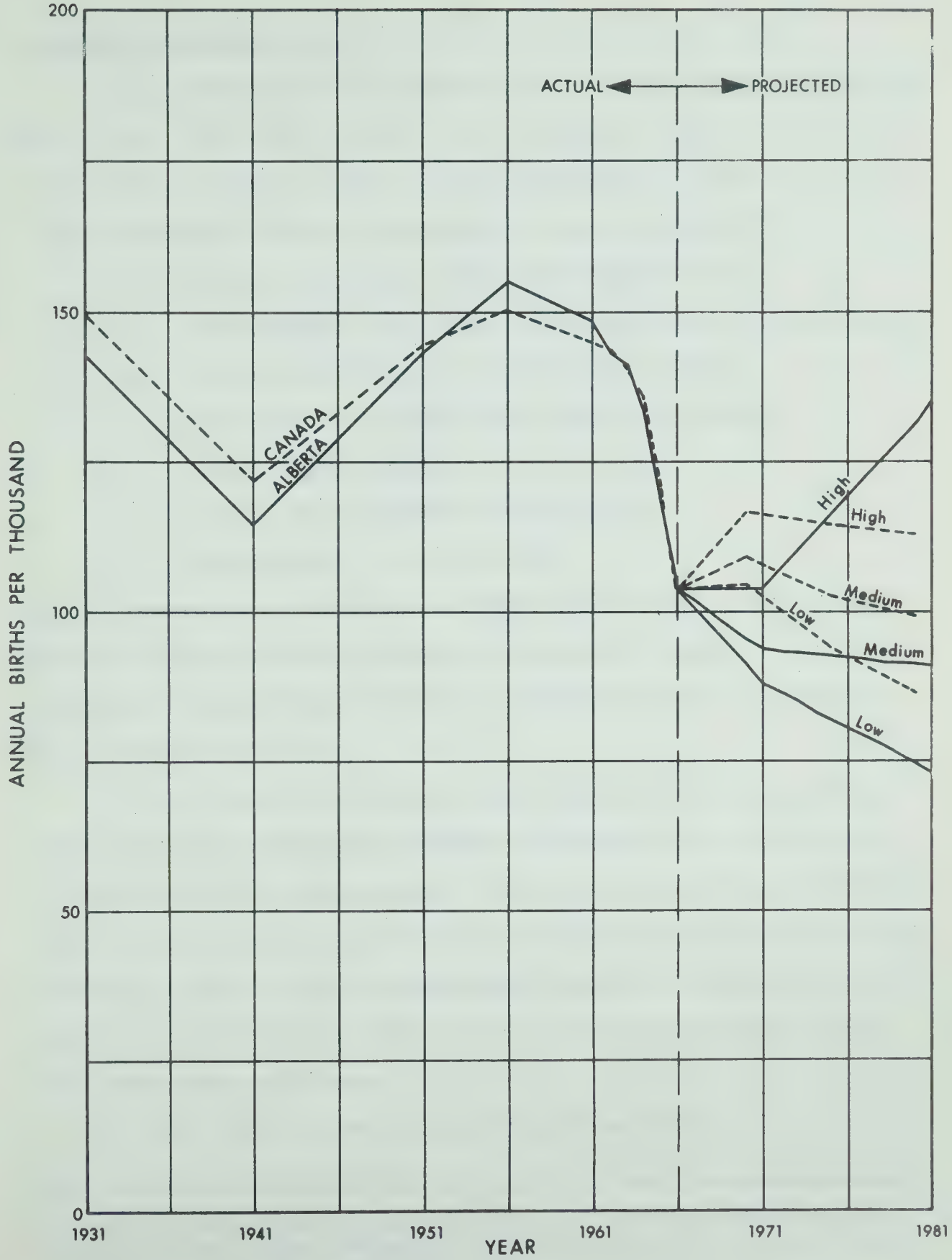


FIGURE 4.6 FERTILITY RATES, ALBERTA and CANADA, AGES 30-34

5. Analysis of Mortality Rates

5.1 Tables 5.1 and 5.2 show historical data for age-specific death rates by sex. The data for males are also plotted on Figures 5.1, 5.2 and 5.3. A visual appraisal of the Figures indicated that historical patterns of male age-specific mortality conformed to one of three types*:

(i) Erratic fluctuations with little apparent trend.
(Age groups: 1-4, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44)

(ii) Relative stability with little apparent trend.
(Age groups 5-9, 10-14, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79)

(iii) A relatively significant secular trend.
(Age groups: 0-1, 80-84, 85+)

Similar figures are not shown for the female data, but inspection of these data showed that the above conclusions for males also applied to the female groups, with the qualification that the 75-79 group should be included in (iii), and the 85+ in (i).

5.2 A more sophisticated analysis was undertaken by computing a linear regression of age-specific death rates against time, using the data for the period 1956 - 1966 inclusive. The statistical results are shown in Table 5.3. The adequacy of fit of the linear regression as indicated by the correlation coefficient was generally only reasonable for certain of the younger and older age groups. The following age groups had statistically significant slope coefficients:

Male: 0-1, 1-4, 5-9, 20-24, 75-79, 80-84, 85+.

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* Of course, these classifications are a function of the scales utilized in the Figures. These scales were chosen to appraise the proportionate significance of variations.

Female: 0-1, 1-4, 5-9, 10-14, 60-64, 65-69, 70-74, 75-79, 80-84. In all these cases the slope coefficient was negative or zero, except for the male age group 20-24.

5.3 The final selection of which age groups should be subject to a trend in mortality rates over time was predicated on consideration of the utility of the statistical results discussed in 5.2, the relative magnitude of the mortality rates for the age group concerned, and the pattern of movement of mortality rates examined for each age group, particularly over the latter half of the period reviewed. This analysis indicated the desirability of extrapolating trends for the following age groups:

Male: 0-1, 20-24, 70-74, 75-79, 80-84, 85+.

Female:0-1, 70-74, 75-79, 80-84, 85+.

In determining an appropriate trend for the above groups, it was concluded that the mere extrapolation of the regression lines would not provide a reasonable projection. Accordingly, a judgement adjustment was made to the extrapolated regression line to mitigate the relative severity of the impact of the least squares slope. This procedure was believed to be justified, having regard for the susceptibility of the regression results to the period for which the data were analyzed, in this case 1956 - 1966, and the general lack of a very close fit between the data for these age groups and the linear hypothesis, with the exception of the age group 0-1. In addition, a minor trend was applied to the male age group 1-4 and the female age group 5-9. The trends applied to these latter groups are not of sufficient magnitude to be significant in terms of the overall population forecast. Consistent with the analysis of fertility, the trends in mortality adopted were not continued beyond 1981, again on the grounds that the continued extrapolation for excessive periods was inappropriate.

5.4 The mortality trends adopted in 5.3 above were tested for

realism in the light of social and medical conditions. It seems likely that further declines in mortality rates for infants and older members of the population may be experienced, since it is precisely such age groups whose mortality rate is most susceptible to advances in medical science and social care. However, it appeared that the extrapolation of negative trends beyond 1981 or the unqualified adoption of least squares lines would necessitate major medical breakthroughs. Of course, such developments constitute a real possibility, but it did not appear suitable to involve an assumption of this nature in the forecast. The mortality rate projected upwards for the male age group 20-24 may possibly reflect increasing accident rates.

5.5 In contrast to the analysis of fertility rates, only one projection of death rates for each age group was adopted. That is, a range of future mortality rates was considered inappropriate. This assumption is justified on two grounds:

(i) the analysis beforehand showed that many age groups possess relatively stable death rates, or show no evidence of trends;

(ii) more importantly, death rates may fluctuate considerably in the future from the levels adopted with little significance on the overall forecast. Even a 50 per cent fluctuation in death rates for all ages would change the 1981 projection by only some 3 per cent.* The present Alberta rates are extremely low for child bearing ages.

5.6 The projected rates are shown in Tables 5.1 and 5.2 and Figures 5.1 to 5.3. The graphs were confined to males, since female rates show similar patterns but tend to be lower and less volatile than those for males.

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* See Table 7.5.

TABLE 5.1

ALBERTA AGE-SPECIFIC MALE MORTALITY RATE(1)
HISTORICAL 1956-1966 AND PROJECTED 1981

	AGE GROUPS									
	0-1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44
1956	*34.0	*1.4	0.6	0.5	1.3	1.6	1.7	1.5	2.2	3.4
1957	*33.5	*1.3	0.6	0.6	1.3	1.9	1.8	1.8	2.0	3.3
1958	*32.7	*1.2	0.5	0.4	1.6	1.6	1.9	1.7	2.0	3.6
1959	*31.6	*1.1	0.4	0.6	1.1	1.8	1.8	2.1	2.0	3.0
1960	30.0	1.0	0.4	0.6	1.4	1.7	1.6	1.5	2.5	3.3
1961	30.8	1.2	0.5	0.5	1.3	1.8	1.7	1.7	2.1	3.3
1962	28.6	1.2	0.4	0.5	1.0	2.0	1.5	1.8	1.9	2.7
1963	27.1	1.2	0.6	0.5	0.9	2.1	1.7	1.7	2.0	3.5
1964	28.0	1.3	0.5	0.4	1.2	2.2	1.5	1.6	2.2	3.1
1965	26.9	0.9	0.3	0.5	1.1	1.9	1.8	1.8	2.1	3.0
1966	24.2	0.9	0.3	0.5	1.5	2.0	1.8	1.6	2.2	3.2
11 YEAR AVERAGE	29.8	1.2	0.5	0.5	1.2	1.9	1.7	1.7	2.1	3.2
LEAST SQUARES ESTIMATE: EXTRAPOLATION TO 1981	12.5	0.6	0.1	0.4	0.9	2.7	1.5	1.7	2.2	2.6
PROJECTIONS: 1971	22.1	0.9	0.4	0.5	1.2	2.1	1.7	1.7	2.1	3.2
1976	20.0	0.8	0.4	0.5	1.2	2.2	1.7	1.7	2.1	3.2
1981	18.0	0.8	0.4	0.5	1.2	2.3	1.7	1.7	2.1	3.2

	AGE GROUPS								
	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
1956	5.1	8.1	12.7	20.4	31.9	47.8	80.1	124.7	219.4
1957	4.7	8.2	13.2	20.3	32.4	49.8	84.0	135.8	220.0
1958	5.9	8.7	13.6	19.9	34.1	49.5	74.3	127.8	197.8
1959	4.9	8.2	13.6	21.1	32.4	49.7	79.0	117.4	215.3
1960	4.6	7.9	12.8	20.7	32.1	52.8	79.8	123.7	220.5
1961	5.0	8.6	12.2	20.4	29.8	46.8	78.1	123.4	192.1
1962	5.3	7.7	13.3	20.7	32.7	51.1	75.5	120.9	198.1
1963	5.1	8.6	12.9	19.5	29.7	49.2	77.2	118.6	193.8
1964	5.6	7.7	12.5	22.0	33.0	48.6	76.6	114.4	186.5
1965	4.6	8.9	13.1	19.8	31.5	48.2	74.3	117.5	191.9
1966	5.1	8.2	12.8	21.3	31.3	46.5	73.3	116.1	203.2
11 YEAR AVERAGE	5.1	8.3	13.0	20.6	31.9	49.1	77.5	121.8	203.5
LEAST SQUARES ESTIMATE: EXTRAPOLATION TO 1981	5.0	8.4	12.1	21.5	29.4	45.9	64.7	94.8	153.0
PROJECTIONS: 1971	5.1	8.3	13.0	20.6	31.9	46.0	72.2	112.4	194.7
1976	5.1	8.3	13.0	20.6	31.9	45.5	71.1	108.9	186.3
1981	5.1	8.3	13.0	20.6	31.9	45.0	70.0	105.0	178.0

(1) AGE-SPECIFIC MORTALITY RATE = $\frac{\text{ANNUAL DEATHS IN SPECIFIED AGE GROUP}}{\text{MID-YEAR POPULATION IN SPECIFIED AGE GROUP}} \times 1000$

* ESTIMATED FROM '0-4' DATA.

SOURCE: D.B.S. VITAL STATISTICS, 1956 - 1966.

TABLE 5.2

ALBERTA AGE-SPECIFIC FEMALE MORTALITY RATE(1)
HISTORICAL 1956-1966 AND PROJECTED 1981

	AGE GROUPS									
	0-1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44
1956	*26.0	*1.2	0.6	0.5	0.5	0.6	0.7	0.7	1.3	1.7
1957	*28.7	*1.4	0.4	0.4	0.7	0.6	0.7	1.0	1.3	1.8
1958	*23.5	*1.0	0.5	0.4	0.7	0.6	0.5	1.1	1.1	1.6
1959	*24.4	*0.9	0.4	0.4	0.5	0.6	0.8	0.7	1.0	1.6
1960	22.2	0.9	0.4	0.4	0.9	0.6	0.8	0.7	1.2	1.9
1961	22.7	0.8	0.3	0.2	0.7	0.5	0.5	0.7	1.3	1.7
1962	22.0	0.9	0.4	0.3	0.5	0.8	0.6	0.8	1.1	2.1
1963	19.9	0.6	0.3	0.2	0.6	0.8	0.5	0.6	1.2	2.1
1964	19.7	1.0	0.3	0.3	0.5	0.7	0.8	0.7	1.4	1.9
1965	21.0	0.6	0.4	0.3	0.5	0.5	0.8	0.8	1.1	1.7
1966	17.6	0.7	0.4	0.3	0.5	0.6	0.7	0.9	1.3	1.7
11 YEAR AVERAGE	22.5	0.9	0.4	0.3	0.6	0.6	0.7	0.8	1.2	1.8
LEAST SQUARES ESTIMATE: EXTRAPOLATION TO 1981	6.6	NEGATIVE	0.1	NEGATIVE	0.3	0.7	0.8	0.6	1.3	2.1
PROJECTIONS: 1971	15.7	0.9	0.4	0.3	0.6	0.6	0.7	0.8	1.2	1.8
1976	13.9	0.9	0.3	0.3	0.6	0.6	0.7	0.8	1.2	1.8
1981	12.0	0.9	0.3	0.3	0.6	0.6	0.7	0.8	1.2	1.8

	AGE GROUPS								
	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+
1956	3.6	4.5	6.8	13.3	21.1	34.5	64.1	91.0	170.6
1957	2.9	5.9	7.8	13.7	19.0	32.2	59.0	101.2	192.8
1958	2.6	5.0	5.9	11.6	19.6	31.9	52.9	105.4	185.3
1959	3.1	4.8	7.1	11.8	17.0	35.1	54.6	99.2	196.8
1960	2.8	5.1	7.4	11.8	19.1	31.2	59.3	95.3	193.5
1961	3.0	3.9	6.3	10.7	17.0	29.1	51.6	92.1	173.4
1962	2.8	3.9	8.6	9.6	17.7	31.1	52.5	91.3	187.7
1963	2.6	4.9	6.7	11.3	18.6	32.6	54.9	91.6	191.9
1964	2.7	4.6	6.5	11.0	17.1	27.0	54.5	80.0	174.1
1965	3.5	4.1	7.3	10.1	16.6	30.0	52.0	85.9	181.7
1966	2.5	4.2	7.2	11.0	18.3	29.0	48.9	88.5	179.7
11 YEAR AVERAGE	2.9	4.6	7.1	11.4	18.3	31.2	54.9	92.9	184.3
LEAST SQUARES ESTIMATE: EXTRAPOLATION TO 1981	2.3	2.7	7.4	6.1	13.2	21.6	34.7	63.7	176.0
PROJECTIONS: 1971	2.9	4.6	7.1	11.4	18.3	28.3	44.3	84.4	179.8
1976	2.9	4.6	7.1	11.4	18.3	27.6	39.7	80.2	179.9
1981	2.9	4.6	7.1	11.4	18.3	27.0	35.0	76.0	180.0

(1) AGE-SPECIFIC MORTALITY RATE = $\frac{\text{ANNUAL DEATHS IN SPECIFIED AGE GROUP}}{\text{MID-YEAR POPULATION IN SPECIFIED AGE GROUP}} \times 1000$

* ESTIMATED FROM '0-4' DATA.

SOURCE: D.B.S. VITAL STATISTICS, 1956 - 1966.

TABLE 5.3

LEAST SQUARES REGRESSION ESTIMATES
ALBERTA MORTALITY RATES 1956 TO 1966

	MALE			FEMALE		
	REGRESSION COEFFICIENT b	t-SCORE	CORRELATION COEFFICIENT r	REGRESSION COEFFICIENT b	t-SCORE	CORRELATION COEFFICIENT r
0-1	-0.91	12.74(s)	0.97	-0.85	6.44(s)	0.91
1-4	-0.03	2.42(s)	0.63	-0.06	3.77(s)	0.78
5-9	-0.02	2.37(s)	0.62	-0.02	2.29(s)	0.61
10-14	-0.01	0.95	0.30	-0.02	3.09(s)	0.72
15-19	-0.02	0.80	0.26	-0.01	1.15	0.36
20-24	0.04	3.16(s)	0.72	0.00	0.45	0.15
25-29	-0.01	0.71	0.23	0.00	0.36	0.12
30-34	0.00	0.16	0.17	-0.01	0.67	0.22
35-39	0.00	0.22	0.07	0.00	0.30	0.10
40-44	-0.03	1.26	0.39	0.02	0.90	0.29
45-49	0.00	0.04	0.01	-0.03	1.01	0.32
50-54	0.01	0.20	0.07	-0.10	1.96	0.55
55-59	-0.04	0.88	0.28	-0.02	0.27	0.09
60-64	0.05	0.72	0.23	-0.28	3.52(s)	0.76
65-69	-0.13	1.08	0.34	-0.27	2.53(s)	0.64
70-74	-0.17	0.95	0.30	-0.51	2.97(s)	0.70
75-79	-0.67	2.97(s)	0.70	-0.96	3.27(s)	0.74
80-84	-1.42	3.55(s)	0.76	-1.54	3.03(s)	0.71
85+	-2.66	2.81(s)	0.68	-0.44	0.49	0.16

(s) INDICATES A SIGNIFICANT t-SCORE FOR THE REGRESSION COEFFICIENT, b. THE CRITICAL t-SCORE VALUE AT THE 95% CONFIDENCE LEVEL IS 2.26 (WITH 9 DEGREES OF FREEDOM).

Table 3.3

-0.01	12.7(+4)		-0.-		
-0.03	2.4e-01		-0.05		
-0.02	2.77 e-				
-0.01	0.95		-0.44		
-0.02	0.38		-0.1		
0.0+	4.12(+)				
-0.11	0.21		.0+		
0.03	0.15				
0.00	0e-12		0.0L		
-0.03	1.2e		-		
0.00	0.00-	0.01	-0.33	1.31	
0.01	0.29	0.1+-	-0.19	.3M	
-0.0+	0.1+				
0.05	0.22	0.24			B
-0.13	1.03	0.1+	-0.1	-.24	0.23
-0.17	0.25	- 0.20	-0.1	2.2(	0.23
-0.07	2.27(+)	0.20	-0.24	2. - 1	-.25
	2.31(+)	3.22	-1.2+	8.03(+)	0.23
	2.31(+)	0.20	-1 .2]	0.52	3.18

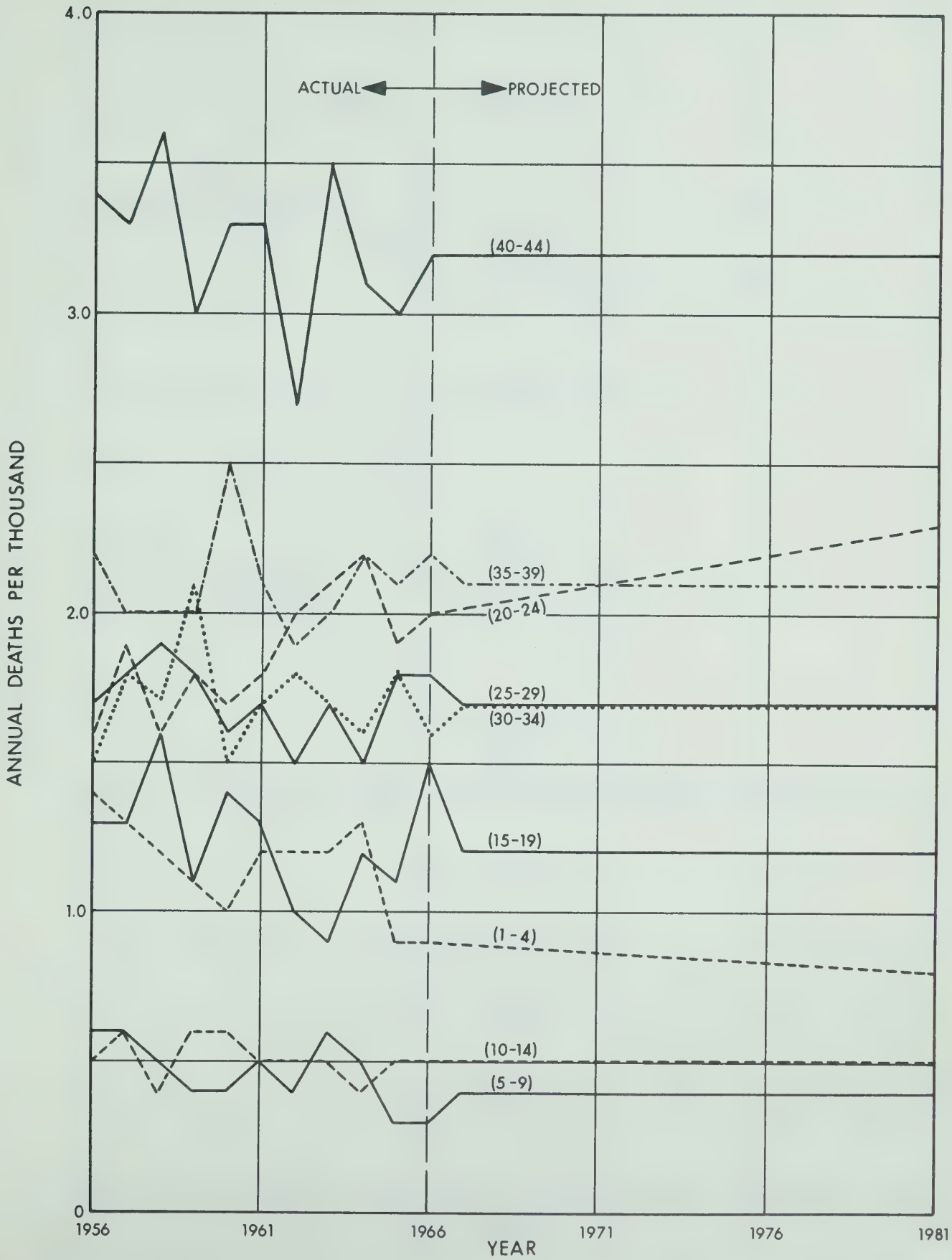


FIGURE 5.1 AGE SPECIFIC MALE MORTALITY RATES, ALBERTA, AGES 1-44

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

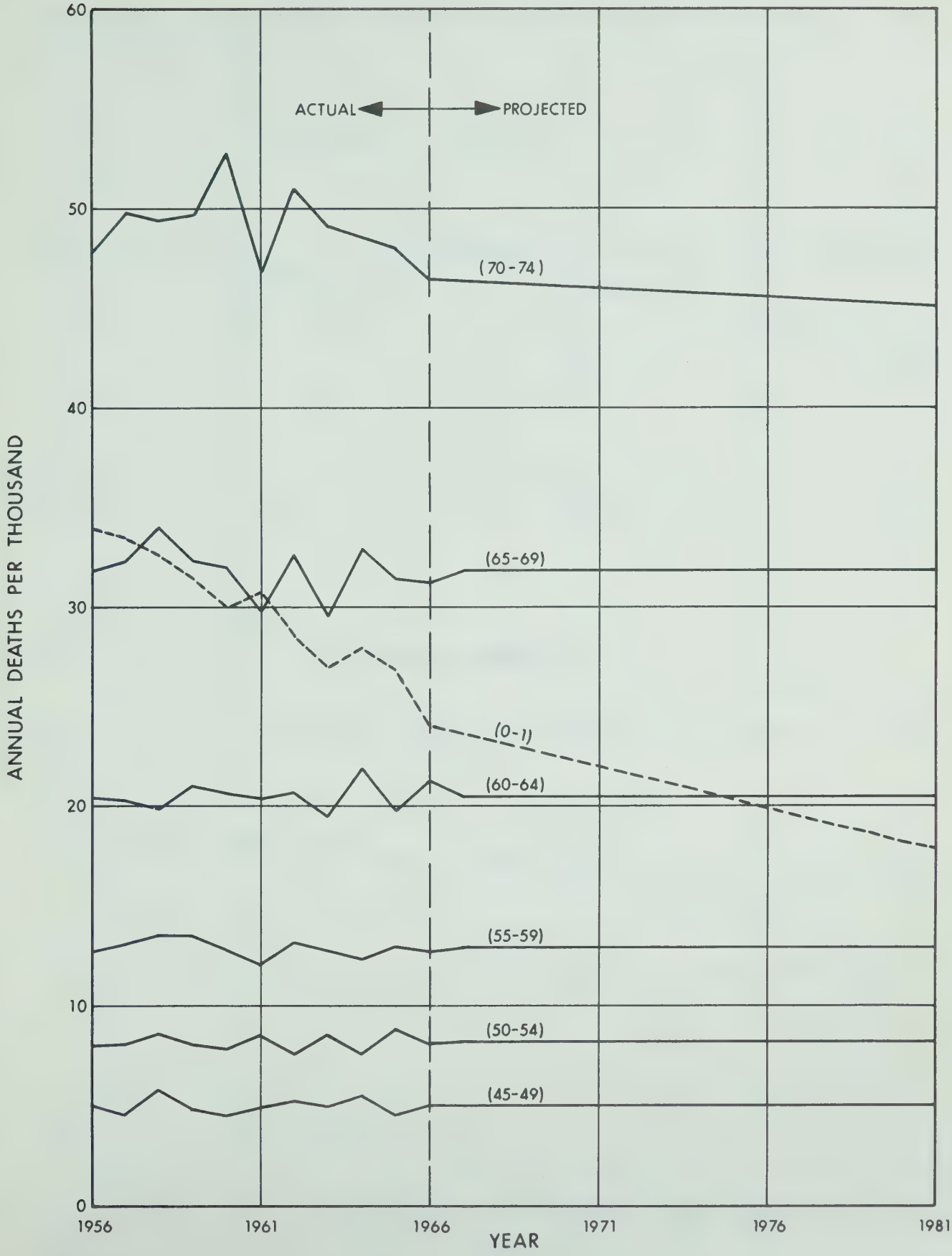
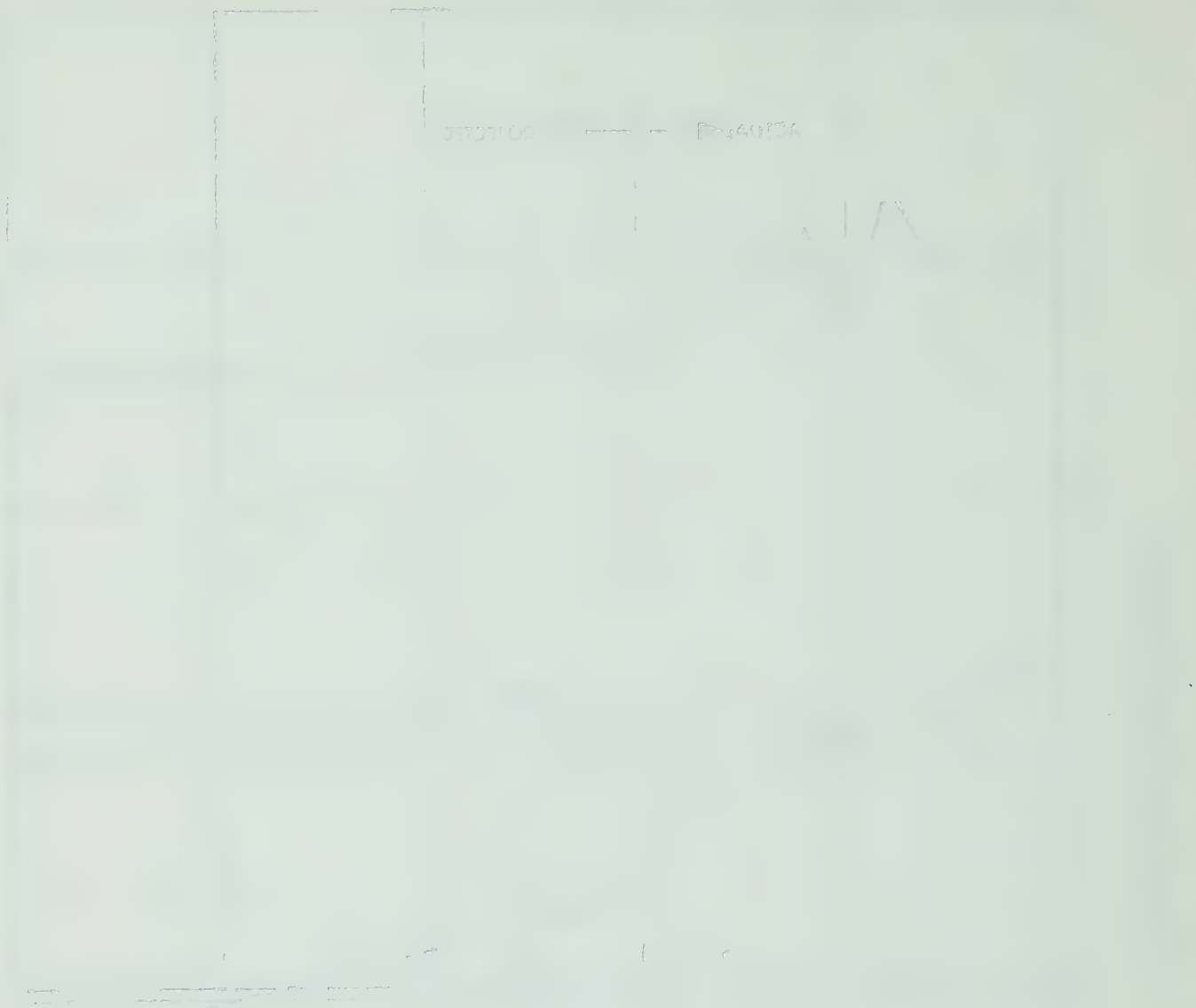


FIGURE 5.2 AGE SPECIFIC MALE MORTALITY RATES, ALBERTA, AGES 0-1 and 45-74



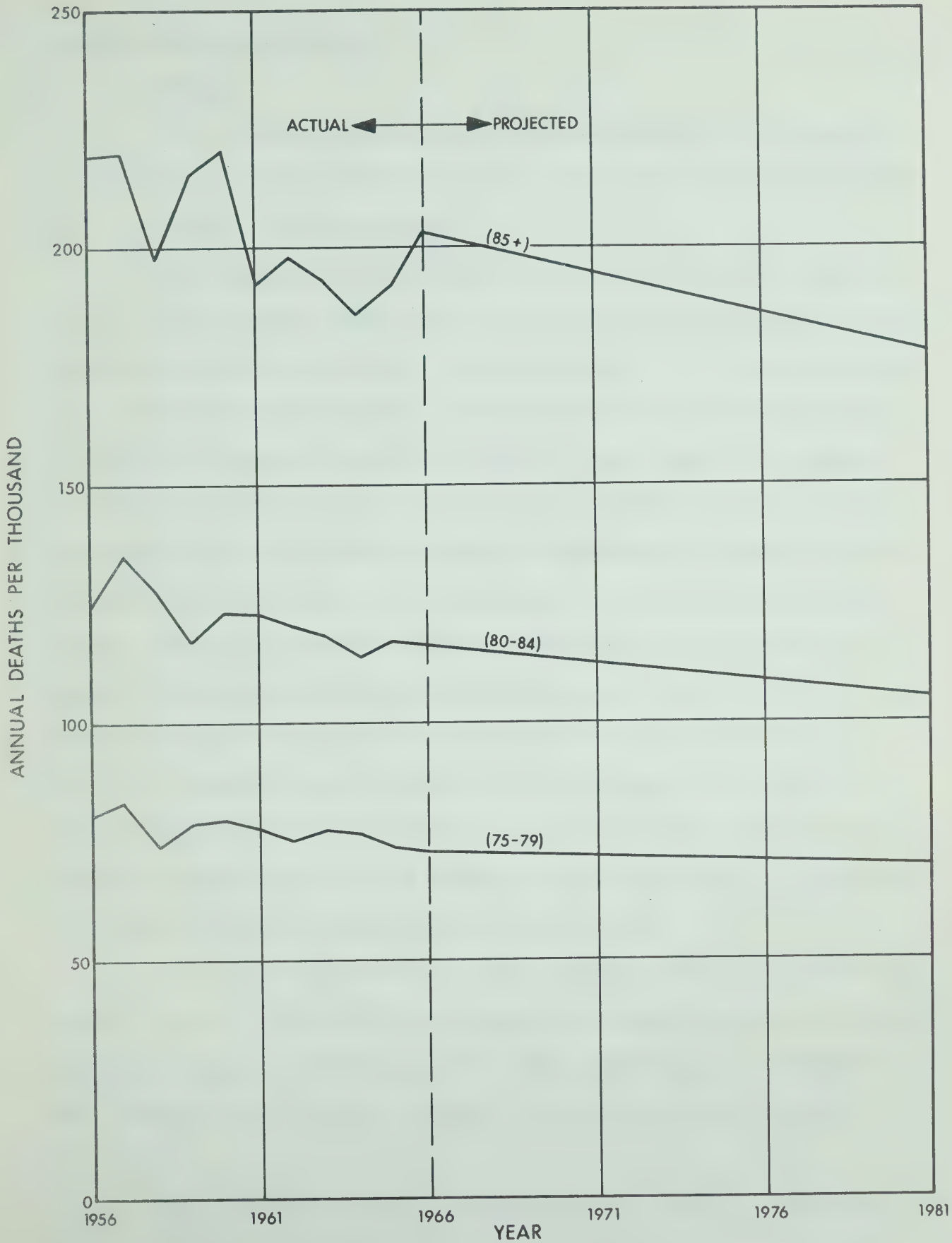


FIGURE 5.3 AGE SPECIFIC MALE MORTALITY RATES, ALBERTA, AGES 75+

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

6. Analysis of Alberta Migration

Method

6.1 No direct estimates of historical immigration or emigration are available for Canadian Provinces. As a consequence, inferential methods must be employed to estimate migration.

6.2 Sampling techniques were adopted by the Dominion Bureau of Statistics (DBS) in the 1961 census to estimate the 'mobility status' of the population over four years of age in each Province. (1) A random sample of one in five households was used. A distinction was observed between interprovincial and international movers, with the former defined as members of a Province's 1961 population who resided in a different Province at the date of the 1956 census. The data relating to interprovincial movers may be differenced to obtain estimates of net migration in this category for each Province. The data concerning international movers include foreign immigration, but exclude Canadian emigration abroad. Hence the international component of net migration may not be computed on a provincial basis. In view of the relatively small sample size, the caveats of DBS itself (1, introd.), the current unavailability of data for the period 1961 - 1966, and the lack of total provincial net migration totals, the analysis of migration on the basis of the DBS sample data was not pursued.

6.3 An alternative method, which was believed to yield reasonably accurate results, is to estimate net migration by comparing the actual and 'natural' increases in population. The natural increase may be defined as that increase which would have occurred in the absence of any migratory influences.

6.4 Two basic methods of estimating the 'natural' increase may be used.

(a) Aggregate calculations on data classified solely by sex, as follows:

$$\text{actual increase} = (\text{population})_{t+1} - (\text{population})_t$$

$$\text{natural increase} = 7/12(\text{births} - \text{deaths})_t + 5/12(\text{births} - \text{deaths})_{t+1}*$$

$$\text{net immigration} = \text{actual increase} - \text{natural increase}**,$$

where the subscripts, t, t+1, refer to years.

The major difficulty with this method is that the DBS Vital Statistics records by Province include immigrant births and deaths and exclude those of emigrants. The difficulty is experienced even in the case of data recorded by place of residence, since legal residence is established after six months. To this extent the 'natural' increase is not properly defined, because the estimate of it may be biased when migration is significant in volume.*** The computer programme implementing this method is referred to as 'MIGAGG'.

(b) Age-specific calculations on data classified by sex and age. This method calculates the natural increase by applying age-specific fertility and mortality rates to the initial or 'base' population, as described in detail in Appendix A. Net migration is computed as the difference between the actual and natural increases. The method depends on the availability of age-specific

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* The use of fractions is necessitated by the fact that census population data are ascertained as of June 1st, whereas birth and death statistics are classified by calendar year (see Appendix A, paragraph 3).

** For a period of n years:

$$\text{actual increase} = (\text{population})_{t+n} - (\text{population})_t$$

$$\text{natural increase} = 7/12(\text{births} - \text{deaths})_t + \sum_{j=t+1}^{t+n-1}(\text{births} - \text{deaths})_j + 5/12(\text{births} - \text{deaths})_{t+n}$$

$$\text{average annual net immigration} = (\text{actual increase} - \text{natural increase})/n$$

*** For example, the natural increase would be overestimated if the excess of immigrants' births over deaths were greater than that for emigrants. See also (2, p. 63).

data, although in the absence of such data assumptions may be made about the age structure of a base population and the corresponding fertility and mortality rates. The programme implementing this method is referred to as 'MIGRAT'. Both the MIGAGG and MIGRAT programmes are described in Appendix B.

6.5 The MIGRAT approach was considered to be more accurate since, to the extent that the applied fertility and mortality rates accurately represent the breeding and mortality characteristics of the original population for the period under review, the influence of migration is properly excluded from the natural increase.* In practice the fertility and mortality rates applied to the base population include data for migrants. However, if breeding and mortality characteristics of migrants are similar to the base population, the definition of the natural increase remains valid. Even if these characteristics were different, the error introduced would be small except under conditions where migrants constituted a significant proportion of the total population. Moreover, the method has the additional advantage of providing estimates of the age structure of net migration. For these reasons, the MIGRAT method was favoured where data permitted its use. Accordingly, provincial estimates of net migration for 1956 to 1966 were obtained from the MIGRAT programme. MIGAGG was used for those periods prior to 1956, since age-specific data were not readily available for Alberta.**

Historical Estimates

6.6 Table 6.1 shows the estimates of average annual net migration

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* Given a natural increase based on births and deaths to the original population, the resultant estimate of net migration will be on a survival basis and reflect the incidence of births and deaths among migrants.

** MIGAGG's estimate of migration for 1956 to 1961 of 12,900 compared with the MIGRAT estimate of some 15,000. (Table 6.1) Since this was a period of relatively high immigration, the direction of the difference between the two estimates tends to confirm the MIGAGG bias referred to in footnote 3 to 6.4 preceding, assuming net immigrant births exceed deaths.

derived from the MIGAGG or MIGRAT method, as appropriate, for 10-year intervals 1921 to 1951, five-year intervals 1951 to 1966 and single years 1956 to 1966.* The present Alberta trend is a definite and sharp decline from the 1960-1961 high of an estimated 20 thousand net immigration to the 1965-1966 low of nine thousand net emigration. However, these single year totals require qualification. In particular, the computation of the actual increase which results from comparing two intercensal population totals may be erroneous, since the intercensal enumerations are estimates and as such subject to inaccuracy.** Furthermore, the burden of reconciliation between the intercensal estimate and the census enumeration is necessarily borne by the estimate of migration in the year immediately preceding the census. The fact that the high and low migration estimates referred to above occur in such years is no coincidence. For instance, the large outflow of males and small outflow of females attributed to the year 1965-1966 probably reflects an excessive 1965 intercensal estimate of male base population, while the 1965 estimate for females may have been low. Given this feature, the average annual estimates for net migration for the five-year intervals between the census years are probably more accurate than the averages of the single-year estimates for the corresponding periods. The averages relating to five- and ten-year intervals are shown for males and females in Figure 6.1.

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* 1956 to 1958 was estimated as one interval since 1957 population data were not readily available.

** The procedure used by D.B.S. in estimating intercensal population is based on the following method:

natural increase: births - deaths, by age and sex.
foreign immigration: Federal Government statistics, by age and sex.
foreign emigration: U.S. and U.K. Statistics on Canadian immigration, by sex, age structure of Canadian immigration to the U.S.
interprovincial migration: family allowance data.
age structure from migrants in 1961 Census Sample (DBS Cat. #98.501).
See D.B.S. Annual Cat. #91-202 for details.

6.7 Table 6.1 includes Canadian migration, the trend of which tends to reflect economic factors. The sizable migratory influx to Canada from Europe during the 1950's was due primarily to non-recurring factors: the acceptance of displaced persons after the war, the Hungarian revolution and Suez crisis. Also, there was a significant disparity in economic opportunity and standard of living between Western Europe and the expanding North American economy, which required additional skilled labour. Alberta experienced a substantial gross inflow of foreign immigrants of some 38,000 persons between 1956 and 1961.* By the early 1960's the situation was reversed. The European economy boomed, while North American labour markets slackened. Canada's net immigration for 1962-1963 was zero. However, labour markets in North America became tight again with the renewal of economic expansion in Canada following the devaluation of the Canadian dollar and the strong growth of the American economy. (4, pp. 20-21) Canadian net immigration rose to 90,000 in 1965-1966. Estimates of Alberta's gross participation in the recent influx are as yet unpublished.

6.8 Table 6.1 shows that the estimated movement of Alberta migration appears to have been contrary to the Canadian trend since 1963. In the absence of detailed evidence, the reasons for the divergence may only be surmised. A partial explanation may be that during the 1950's and early 1960's, Alberta's economy was expanding more rapidly than other areas in Canada and unemployment rates were lower. Consequently, Alberta acquired an attractive posture both for immigrants from abroad and from other Provinces. In the mid 1960's, economic expansion in British Columbia, Quebec and Ontario, as reflected by the significant reduction in unemployment rates

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* (1, p. 11). It is not possible to determine the level of net foreign immigration (see 6.2 preceding).

over this period*, has tended to eliminate the relative advantage enjoyed by Alberta. It is noteworthy that although the Alberta petroleum industry has continued to grow rapidly and farm income has remained high, neither of these industries - which during the 1960's have contributed some 50 per cent to the total value of Alberta's net provincial production - is labour intensive. (3, p. 12)

Projections of Migration

6.9 Two difficulties are inherent in projecting migration for Alberta. First, the historical estimates shown in Table 6.1 are subject to error. Second, the volatility of the estimated historical series makes the extrapolation of trends a hazardous operation. Accordingly, to accommodate possible variations, a range of migration projections was adopted. In particular, three trends were projected, as shown in Table 6.1 and Figure 6.1. Each projection was held constant throughout the entire period 1966 to 1996. The high projection, 10,000 net immigration, was based on an assumed reversion of net immigration to levels somewhat less than the 13,800 achieved during the peak 10-year immigration period 1951 to 1961. The downward adjustment from the 10-year peak period was intended to reflect a more realistic approach to extrapolation over a 30-year period. It also assumed that the

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* Unemployment rates (percentages)

	Prairie Provinces	British Columbia	Ontario	Quebec	Canada
1958	4.1	8.5	5.4	8.8	7.1
1961	4.6	8.5	5.5	9.2	7.2
1964	3.1	5.3	3.2	6.4	4.7
1966	2.1	4.4	2.5	4.7	3.6

Source: Economic Council of Canada, Third Annual Review, 1966.

The decline in unemployment rates for the Prairie Provinces probably embraces a greater relative decline in Saskatchewan and Manitoba than Alberta.

economic objectives now espoused by Canadian Governments will lessen the likelihood of a reappearance of the relatively high unemployment rates experienced in the late 1950's and early 1960's in the most populous Provinces - British Columbia, Ontario and Quebec - which possibly enhanced the attractiveness of Alberta to migrants. The high projection was split evenly between males and females, in conformity with the 1956 to 1961 patterns.

6.10 The medium projection of zero net migration confines the growth in provincial population to its 'natural' increase. The implicit assumption of this projection is that the estimates of net emigration for the period 1963 to 1966 do not express a long term trend. Rather, recent emigration may constitute a non-recurring adjustment, reflecting the relative improvement in opportunities for migrants in other areas of high prosperity in Canada. On the other hand, it was assumed that continuing prosperity in other areas of Canada and the commitment of Government policies to the maintenance of high levels of employment and the elimination of regional disparities would preclude the return of Alberta to the status of a 'net' immigrant Province. The latter also reflects a presumption that petroleum and agriculture would remain as the principal components of the Alberta economy. As remarked previously, neither industry is labour intensive.

6.11 The low projection, 6,500 net emigration, assumes that the present outflows will continue at somewhat less than the average rate of 7,300 estimated for the period 1964 - 1966. Of note is the fact that the increasing trend in net emigration shown in Table 6.1 may be more apparent than real, given the impact of the reconciliation between the intercensal and census populations in the year 1965-1966, referred to in paragraph 6.4. Furthermore, as in the medium case, it may be that a certain proportion of the current estimated net emigration is non-recurring in nature and as such

not suitable for incorporation in a 30-year projection. The assumed level of net emigration was split 5,000 to 1,500 in favour of males, since the latter have apparently dominated the period of outflow. The female figure is the actual average of the 1964 - 1966 estimates, while the male figure is 1,000 less than the corresponding male average. The adoption of a lower male:female ratio than the 1964 - 1966 estimate presumed that the projection of a higher ratio over the entire term of the forecast would be inappropriate. The relatively low level of total net emigration also implicitly presumes that Alberta will not experience any sustained economic decline, relative to the rest of Canada. This is in accordance with the assumptions made for other regions in paragraph 6.10.

Age Structure of Projected Migration

6.12 As a basis for postulating an age distribution for the migration projections, five-year age group shares of historical net migration were calculated. These are shown in Tables 6.2 and 6.3 for males and females respectively, for the period 1956 to 1966. Theorizing concerning the age structure of immigration and emigration utilizing such estimates is dangerous since the relative magnitudes of immigration and emigration are unknown. Nevertheless, certain features of the distributions shown in these tables are of interest. Younger members of the working force are potentially more mobile, as are younger families, since in the latter instance changes in location are easier to accommodate for children in early stages of education. Conversely, older students and senior members of the working force tend to be less mobile: adjustment to new curricula is difficult for such students; older workers tend to be 'locked in' by pension plans and less disposed to change location after a long period of residence. Thus, a priori, the apparent domination during periods of high net immigration by the age

groups '0-9' and '20-39' for both sexes, with the rest of the population remaining stable, appears reasonable. To some extent the same effect may be anticipated in the period of net emigration, although the estimates indicate domination over a wider age group - males '10-19', '30-59', females '30-59' and children '0-4'. The net inflow of females of ages '15-29' in the period of net emigration may result from an outflow of married females, corresponding to a portion of the male outflow, being more than offset by a heavy inflow of young single females into the Alberta labour force, possibly from other Prairie Provinces. Such a pattern would account for the still significant female outflow in the age group '0-4'.

6.13 The age structures of male and female survivor migrants, shown in Tables 6.2 and 6.3 respectively, were examined in relation to a net immigration period, 1956 - 1961, and a net emigration period, 1964 - 1966. The average proportionate age distribution of migration relating to the former period is shown for males in column 1, and for females in column 3, of Table 6.4. The data regarding the period of net emigration are depicted in the corresponding columns of Table 6.5. The averages for each period are based on the interval as a whole and not on the average of the single year estimates. To derive representative age distributions for the 30-year projections, these averages were smoothed to remove possible anomolies and to accommodate age distributions peculiar to each time period. An example of the latter is the small number of 15-19 year olds involved in net immigration during 1956 - 1961, a fact that may reflect the actual age structure of the population in Canada and in Europe - fertility rates were low in the period 1940 to 1945 - more than a specific migratory characteristic. The assumed male and female age structures for migration based on these adjustments are shown in columns 2 and 4 respectively of Tables 6.4 and 6.5, and

are illustrated pyramid fashion in Figure 6.2. The application of the assumed migration age distributions to the projected levels of net immigration and emigration is shown in Table 6.6.

References

(1) D.B.S. 1961 Census. Vol. IV, Cat. No. 98-509.

(2) E.C.C. Staff Study No. 13, 'Internal Migration in Canada, 1921-1961' (March, 1966).

(3) Alberta Bureau of Statistics. 'Alberta Industry & Resources' (January, 1968).

(4) E.C.C. Staff Study No. 19, 'Population, Family and Labour Force Growth to 1980' (September, 1967).

Table 6.1

Estimated Average Annual Net Immigration
Alberta and Canada
(June 1 to May 31)

Intervals	Male	Female	Total	Canada
			Historical	
'MIGAGG' estimates				
1921 - 1931	2,561	1,271	3,832	46,817
1931 - 1941	-2,358	-1,838	-4,196	-13,007
1941 - 1951	-665	-356	-1,021	34,264
1951 - 1956	7,163	5,388	12,551	100,000
'MIGRAT' estimates*				
1956 - 1958	6,801	5,531	12,332	140,000
1958 - 1959	8,008	7,068	15,076	50,000
1959 - 1960	5,518	5,240	10,758	30,000
1960 - 1961	10,378	9,608	19,986	10,000
1961 - 1962	4,200	4,616	8,816	2,000
1962 - 1963	3,133	3,175	6,308	0
1963 - 1964	-131	-622	-753	30,000
1964 - 1965	-2,702	-2,994	-5,696	40,000
1965 - 1966	-9,372	60	-9,312	90,000
1964 - 1966	-6,088	-1,512	-7,600	65,000
1956 - 1961	7,932	7,003	14,935	80,000
1961 - 1966	-865	1,006	141	40,000
		Projected 1966 - 1996		Canada 1965 - 1980
High	+5,000	+5,000	10,000	120,000
Medium	0	0	0	70,000
Low	-5,000	-1,500	-6,500	20,000

Sources: Alberta 1921 - 1956 MIGAGG Programme
Alberta 1956 - 1966 MIGRAT Programme
Canada 1921 - 1951 MIGAGG Programme; 1951 - 1980 E.C.C. Staff Study #19, p. 21.

* On a survivor basis.

TABLE 6.2

ALBERTA
ESTIMATED AVERAGE ANNUAL AGE-SPECIFIC
MALE NET SURVIVOR MIGRATION 1956 - 1966
(JUNE 1 TO MAY 31)

AGE	INTERVAL											
	1956-1961*	1961-1966*	1956-1958	1958-1959	1959-1960	1960-1961	1961-1962	1962-1963	1963-1964	1964-1965	1965-1966	1964-1966**
0-4	872	93	1,125	922	730	196	1,347	335	148	-861	-1,612	-1,147
5-9	1,052	-1	314	456	591	1,508	-560	279	108	-336	339	-144
10-14	478	-85	528	466	483	676	345	268	-19	-303	-597	-395
15-19	164	-320	658	467	441	-440	471	433	74	60	-1,718	-878
20-24	801	7	1,369	1,017	1,119	-325	501	624	-19	-74	-658	-421
25-29	1,546	351	1,073	1,069	936	2,662	513	20	-456	-377	638	182
30-34	1,066	-111	875	601	601	2,602	396	259	176	4	-919	-392
35-39	756	-159	471	540	370	977	350	204	115	-255	-1,046	-689
40-44	310	-206	246	359	123	489	138	177	-154	-203	-1,282	-769
45-49	234	-199	285	359	119	73	196	-55	-67	-259	-1,011	-614
50-54	62	-139	-34	98	157	-376	100	219	21	-8	-652	-344
55-59	125	-118	-20	241	46	468	57	-64	-213	-333	-632	-476
60-64	53	-75	16	254	78	276	65	118	158	127	-351	-118
65-69	127	-53	27	240	-47	-95	-1	39	86	-27	-390	-227
70-74	117	78	-124	131	33	603	13	-137	-299	-89	385	156
75-79	42	-6	-87	151	-43	461	-5	140	193	113	-2	70
80-84	53	17	24	13	-115	242	18	100	-90	98	-88	-28
85+	74	61	55	624	-104	381	256	174	107	21	224	146
TOTAL	7,932	-865	6,801	8,008	5,518	10,378	4,200	3,133	-131	-2,702	-9,372	-6,088

(-) DENOTES NET OUTFLOW.

*. PROGRAMME RUN ON FIVE-YEAR INTERVAL BETWEEN CENSUS YEARS.

** PROGRAMME RUN ON TWO-YEAR INTERVAL 1964 INTERCENSAL TO 1966 CENSUS YEAR.

TABLE 6.3

ALBERTA
ESTIMATED AVERAGE ANNUAL AGE-SPECIFIC
FEMALE NET SURVIVOR MIGRATION 1956 - 1966
(JUNE 1 TO MAY 31)

AGE	INTERVAL											
	1956-1961*	1961-1966*	1956-1958	1958-1959	1959-1960	1960-1961	1961-1962	1962-1963	1963-1964	1964-1965	1965-1966	1964-1966**
0-4	789	-77	1,107	712	545	401	1,150	467	149	-827	-2,659	-1,654
5-9	1,021	142	246	399	711	1,221	-690	201	-133	-112	1,392	476
10-14	488	-138	374	271	562	1,123	272	293	-93	-337	-710	-431
15-19	244	118	477	397	244	385	327	546	357	199	627	329
20-24	1,032	703	1,009	800	1,004	1,394	726	492	-418	-515	2,566	1,037
25-29	1,132	375	763	598	708	2,816	596	274	-181	-394	1,226	469
30-34	832	-30	752	685	411	1,038	479	383	139	-206	-524	-379
35-39	593	29	240	460	338	1,369	336	26	-383	-395	-305	-370
40-44	245	-142	169	258	260	121	285	219	234	97	-826	-352
45-49	163	-152	163	256	175	2	260	-31	-272	-402	-904	-671
50-54	81	-92	45	298	175	-73	242	41	60	-13	-485	-249
55-59	115	-23	106	442	107	-316	213	7	-74	-38	-327	-198
60-64	36	70	56	269	103	-201	173	61	-64	-17	181	92
65-69	95	72	-1	229	89	-94	85	88	26	-40	257	104
70-74	90	91	-28	164	0	281	38	-36	-167	-24	320	145
75-79	-11	-4	-17	147	110	-122	-19	61	50	114	-22	49
80-84	17	-3	9	34	-105	8	-33	64	45	-42	-27	-32
85+	41	67	61	649	-203	259	176	19	103	-42	280	123
TOTAL***	7,003	1,006	5,531	7,068	5,240	9,608	4,616	3,175	-622	-2,994	60	-1,512

(-) DENOTES NET OUTFLOW.

* PROGRAMME RUN ON FIVE-YEAR INTERVAL BETWEEN CENSUS YEARS.

** PROGRAMME RUN ON TWO-YEAR INTERVAL 1964 INTERCENSAL TO 1966 CENSUS YEAR.

*** TOTALS CORRESPOND TO TABLE 6.1 AND MAY DIFFER FROM SUM OF AGE-GROUPS.

Table 6.4

Alberta
Age-specific Distribution of
Projected Net Migration

Net Immigration

	Male		Female	
	% 1956-1961	% adjusted	% 1956-1961	% adjusted
0-4	11.0	11	11.3	11
5-9	13.3	13	14.6	14
10-14	6.0	5	7.0	6
15-19	2.1	4	3.5	5
20-24	10.1	10	14.7	15
25-29	19.5	20	16.2	17
30-34	13.4	13	11.9	12
35-39	9.5	9	8.5	8
40-44	3.9	4	3.5	3
45-49	2.9	3	2.3	3
50-54	0.8	1	1.2	1
55-59	1.6	2	1.6	2
60-64	0.7	1	0.5	1
65-69	1.6	1	1.4	1
70-74	1.5	1	1.3	1
75-79	0.5	0	-0.2	0
80-84	0.7	1	0.1	0
85+	0.9	1	0.6	0
	100.0	100	100.0	100

Negative sign indicates net outflow.
Adjustment smooths distribution and allows for effects of age distributions peculiar to the sample years.
% share = 100 x (age and sex group net migration/total net migration by sex).

Table 6.5

Alberta
Age-specific Distribution of
Projected Net Migration

Net Emigration

	Male		Female	
	% 1964-1966	% adjusted	% 1964-1966	% adjusted
0-4	18.8	15	109.3	90
5-9	2.4	3	-31.5	-20
10-14	6.5	7	28.5	25
15-19	14.4	15	-21.7	-20
20-24	6.9	7	-68.5	-65
25-29	-3.0	-3	-31.0	-30
30-34	6.4	7	25.0	25
35-39	11.3	12	24.5	25
40-44	12.6	13	23.3	25
45-49	10.1	10	44.3	45
50-54	5.7	6	16.5	20
55-59	7.9	8	13.1	15
60-64	1.9	2	-6.1	-5
65-69	3.7	4	-6.9	-5
70-74	-2.6	-3	-9.6	-10
75-79	-1.1	-1	-3.2	-5
80-84	0.5	0	2.1	0
85+	-2.4	-2	-8.1	-10
	100.0	100	100.0	100

Negative sign indicates net inflow.
Adjustment smooths distribution and allows for effects of age distributions peculiar to the sample years.
% share = 100 x (age and sex group net migration/total net migration by sex).

Table 6.6

Alberta
Projected Age-specific
Net Migration

	Low (Net Emigration)		High (Net Immigration)	
	Male	Female	Male	Female
0-4	-750	-1,350	550	550
5-9	-150	+300	650	700
10-14	-350	-375	250	300
15-19	-750	+300	200	250
20-24	-350	+975	500	750
25-29	+150	+450	1,000	850
30-34	-350	-375	650	600
35-39	-600	-375	450	400
40-44	-650	-375	200	150
45-49	-500	-675	150	150
50-54	-300	-300	50	50
55-59	-400	-225	100	100
60-64	-100	+75	50	50
65-69	-200	+75	50	50
70-74	+150	+150	50	50
75-79	+50	+75	0	0
80-84	0	0	50	0
85+	+100	+150	50	0
	-5,000	-1,500	+5,000	+5,000

Positive sign indicates net immigration (inflow).

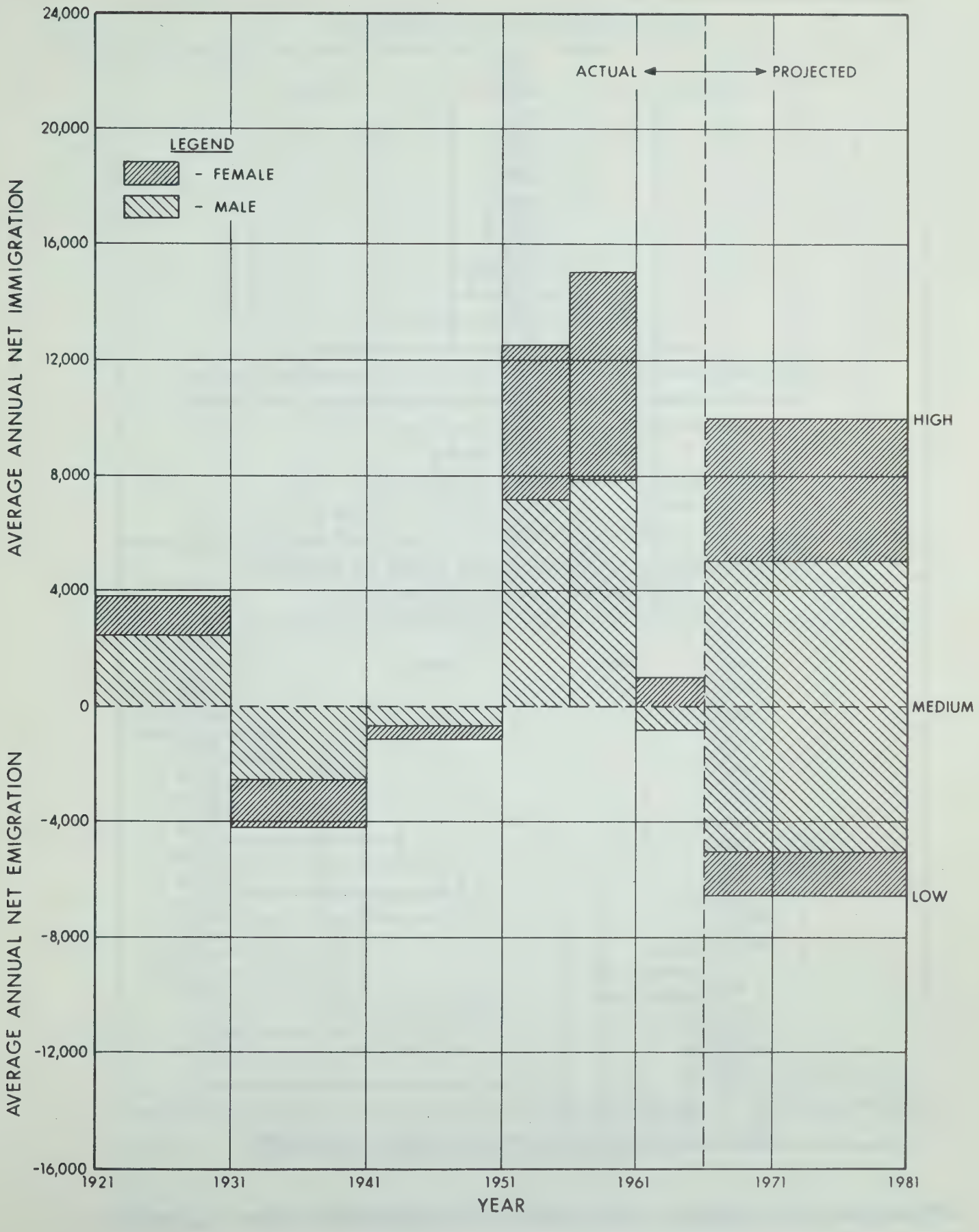

FIGURE 6.1 ESTIMATED ALBERTA NET MIGRATION

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

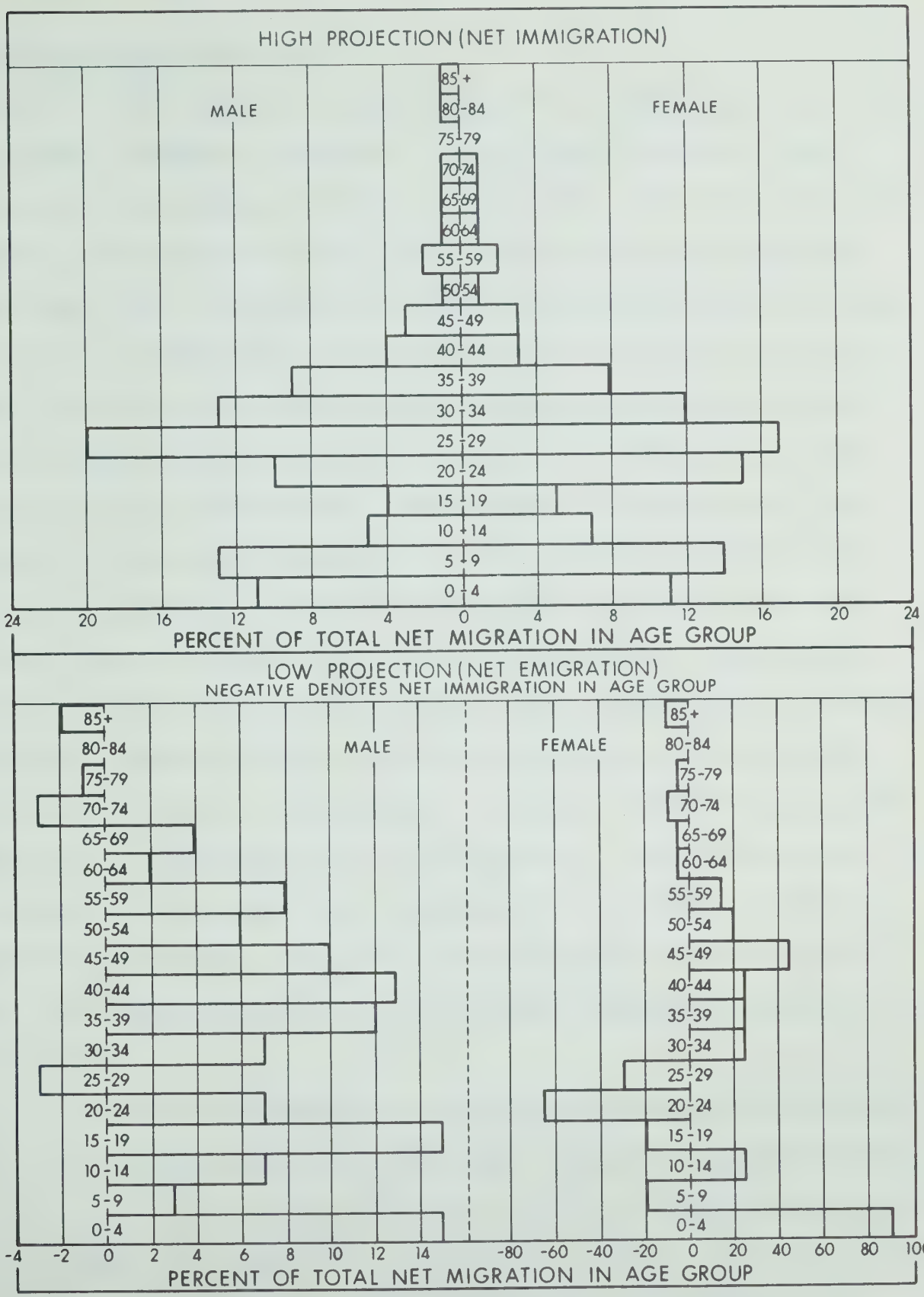

FIGURE 6.2 AGE DISTRIBUTION OF PROJECTED ALBERTA NET MIGRATION

7. Forecasts of Alberta Population

7.1 The population forecasting programme, POPUL, was predicated on the model described in Appendix A. The 1966 census by sex and single years of age constituted the initial population base. Projected death and fertility rates were input by sex and five-year age group and distributed among single years of age within each age group by the application of Sprague multipliers.* Estimated net migration was input in the form of male-female totals. The latter were attributed to five-year age groups by the application of assumed migration age distributions prior to allocation over single years of age by the Sprague method. Net migration for single years of age was added to the generated population at the end of each interval of time.

7.2 POPUL was run on nine sets of data resulting from the combination of three sets of fertility rates and three levels of migration adopted in Sections 4 and 6 respectively. The cases were numbered for reference by a two digit method, with the first digit referring to the fertility assumption and the second to the migration assumption. The low assumption was denoted by '1', the medium by '2' and the high by '3', for both fertility and migration. For example, Case 1.3 designates the low fertility, high immigration assumptions. The lower limit of the projections is given by Case 1.1; the upper limit by Case 3.3. The Case 2.2 projection indicates the medium trend.

7.3 The projections for the two limiting cases and the intermediate case using the 1966 census population of 1,462 thousand** are shown overleaf:

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* For details, see Appendix B

** Population aged 90+ was deleted as death rates for this age group were not available. There were only 1,636 Albertans over 90 in 1966, or some 0.1 per cent of the Province's population.

Case	Fertility Assumption	Immigration Assumption	Population (thousands) 1981	1996
1.1	low	low	1,663	1,851
2.2	medium	medium	1,800	2,193
3.3	high	high	2,086	3,025

The average annual growth rates to 1996 for the three projections are 0.8, 1.4 and 2.4 per cent* respectively. The average growth rate over the 30-year period 1931 to 1961, which commenced in the depression and included the peak growth years of the 1950's, was close to 2 per cent, as shown in Table 7.1.

7.4 Table 7.2 is a summary table showing the nine projections by sex for 15-year intervals. Table 7.3 shows the same projections at five-year intervals. Figure 7.1 combines the historical data of Table 7.1 with the projections of Table 7.3. This Figure indicates that Case 1.3 appears to extrapolate the 1961 to 1966 growth; the slope of Case 2.3 is similar to the 1951 - 1961 trend. Case 1.1, the lower limit, results in a population trend approximating that which occurred from 1941 to 1951: overall, a period of relatively low birth rates. Thus, even under the lowest case, the population trend does not return to the almost stagnant levels of the 1930's. This is consistent with the assumption that economic depression of the severity of that occurring in the 1930's would not be experienced during the forecast period. It is further apparent that the slopes of the cases involving high fertility - 3.1, 3.2, 3.3 - tend to progressively increase beyond 1971. This feature in part reflects the age structure of the 1966 population base, with the predominance of the younger age groups which move into the reproductive age groups during the term of the forecast.

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* This is the rate of growth compounded annually, based on the 1966 initial and the 1996 terminal, populations.

Age Distribution

7.5 Table 7.4 compares the 1966 age distribution to that projected for 1981 and 1996 under Cases 1.1, 2.2 and 3.3. The comparisons are plotted pyramid fashion in Figures 7.2, 7.3 and 7.4. Case 1.1 exhibits a marked decrease in the share of age groups 0-19 in favour of age groups 20-34 in 1981 and 30-44 by 1996. This pattern principally reflects the maturing of the 1966 base population. The significance of the latter in the determination of future age structure is accentuated by the low fertility rate assumption for Case 1.1. Case 2.2 is similar to Case 1.1, but the effects are less pronounced, due mainly to the higher fertility rates assumed. For Case 3.3, the 1981 projection shows some departure from the 1966 distribution, for instance in the 20-29 age groups. However, no uniform pattern is evident. By 1996, Case 3.3 exhibits a population distribution similar to that of the 1966 base population. This similarity in age structure appears to reflect in part the significant contribution made by rising fertility and immigration to the generation of the respective populations.

7.6 Table 7.4 also shows the proportion of the total population constituting the 'labour force source population' (LFSP)* in 1966, 1981 and 1996 under Cases 1.1, 2.2 and 3.3. In all cases the share of the LFSP in the total population increased to 1981. However, from 1981 to 1996 Case 1.1 showed no change, Case 2.2 a two percentage point decrease, while in Case 3.3 the share reverts to approximately the 1966 level. Figure 7.5 illustrates the three LFSP projections. Under Case 2.2 the LFSP increased by some 310,000, 1981 over 1966, and by some 520,000, 1996 over 1966. All persons entering the LFSP during the first half of the forecast period were

* Defined as ages '15-64', inclusive.

alive in 1966. Consequently, the differences between the cases prior to 1981 solely reflect the different assumptions with respect to migration. The two lower curves of Figure 7.5 - Cases 1.1 and 2.2 - exhibit a decrease in slope during the latter half of the forecast period. In contrast, the slope of Case 3.3 remains virtually constant and then increases toward the end of the forecast period. The primary reason for these variations in slope between cases is the impact of the different fertility rate projections utilized during the period 1966 to 1981 on the LFSP after 1981.

Sex Distribution

7.7 The proportion of males in Alberta has historically exceeded females. However, over the period 1921 to 1966, as shown in Table 7.1, the difference has consistently narrowed. Under all cases a continuation of this trend is experienced. Moreover, in most cases the trend extends beyond parity. By 1991, females outnumbered males in all projections but 3.2 and 3.3, where they are roughly equal.* These results indicate that the substantially lower female as opposed to male death rates more than offset the effect of slightly higher male birth ratios, except in Cases 3.2 and 3.3, where fertility rates are high. It would also appear that in Case 3.1 the effect of the high fertility rates in mitigating the trend towards a feminine majority appears to be more than offset by the male predominance in the net emigration total.

Sensitivity Analysis

7.8 A sensitivity analysis was undertaken to determine the relative impact on the projections of changes in the underlying parameters. The base case utilized constant 1966 fertility and death rates and the high

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* See Table 7.3.

immigration assumption.* As in the projections, birth sex ratios were held constant at their 1956 - 1966 average. Parameters were increased and decreased by 50 per cent respectively and the associated projections generated by the POPUL programme.

7.9 The results of the sensitivity analysis are summarized in Table 7.5. The death rates were the least sensitive parameter: 1996 population projections changed by less than five per cent in response to a 50 per cent variation. The same proportionate variations in immigration resulted in a change of about eight per cent in the 1996 projection. This comparison requires qualification, since responsiveness to changes in migration is a function of the absolute levels of migration assumed, in this case a variation of plus or minus 5,000 from a level of 10,000; much larger changes in the volume of immigration are conceivable. In contrast, the possibility of variations larger than 50 per cent in death rates is remote. Thus, it is evident that migration is potentially a more important determinant of population than the sensitivity analysis indicates.

7.10 Fertility rates are the most sensitive of the population parameters projected: the 1996 projection changed by 31 and 27 per cent respectively in response to a positive and negative variation of 50 per cent. The degree of sensitivity is influenced by the high proportion of females aged 0-14 in the original population, since these females pass through the most fertile age groups during the period 1971 to 1996.

7.11 Table 7.5 shows that equal positive and negative variations in death and fertility rates do not result in symmetrical variations in the population projection, except for fertility in 1981, a consequence of the

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* The medium migration case was not used since the migration assumption of zero precluded proportionate changes.

compounding effect of the assumed changes in the parameters. This effect, in terms of fertility rates, is not realized until after 1981, since it is not relevant until children born during the term of the forecast themselves reach the fertile age groups. The immigration variations give symmetrical results since these are additions to, or deletions from, the base population.

Table 7.1

Alberta Census Population 1921 to 1966
at June 1

	Male	%	Female	%	Total	AAGR* %
1921	324,208	55.1	264,246	44.9	588,454	
						2.2
1931	400,199	54.7	331,406	45.3	731,605	
						0.9
1941	426,458	53.6	369,711	46.4	796,169	
						1.7
1951	492,192	52.4	447,309	47.6	939,501	
						3.7
1956	585,921	52.2	537,195	47.8	1,123,116	
						3.5
1961	689,383	51.8	642,561	48.2	1,331,944	
						1.9
1966	746,245	51.0	716,958	49.0	1,463,203	
1931-1961						2.0

Source: 1961 Census (DBS Cat. #92.542), Table 20.
1966 Census (DBS Cat. #92.610), Table 21.

* AAGR = Average Annual Compound Growth Rate.

TABLE 7.2

ALBERTA POPULATION PROJECTIONS BY SEX,
1981 AND 1996
AT JUNE 1
('000's)

CASE	FERTILITY	IMMIGRATION	1981 MALE	1981 FEMALE	1981 TOTAL	15 YEAR AAGR* %	1996 MALE	1996 FEMALE	1996 TOTAL	30 YEAR AAGR* %
1.1	LOW	LOW	811	852	1,663	0.9	877	974	1,851	0.8
2.1	MEDIUM	LOW	841	881	1,722	1.1	980	1,072	2,052	1.1
3.1	HIGH	LOW	895	932	1,827	1.5	1,182	1,266	2,448	1.7
1.2	LOW	MEDIUM	877	869	1,746	1.2	996	1,006	2,002	1.1
2.2	MEDIUM	MEDIUM	904	896	1,800	1.4	1,094	1,099	2,193	1.4
3.2	HIGH	MEDIUM	956	945	1,901	1.8	1,288	1,283	2,571	1.9
1.3	LOW	HIGH	962	956	1,918	1.8	1,183	1,197	2,380	1.6
2.3	MEDIUM	HIGH	993	985	1,978	2.0	1,294	1,303	2,597	1.9
3.3	HIGH	HIGH	1,048	1,038	2,086	2.4	1,513	1,512	3,025	2.4

* AAGR = AVERAGE ANNUAL COMPOUND GROWTH RATE.

Table 7.3

Alberta Population Projections by Sex -
Five-year Intervals
at June 1
('000's)

		Male	% Total	Female	% Total	Total	AAGR %
Case 1.1	FERTILITY LOW, IMMIGRATION LOW						
	1971	766	50.1	762	49.9	1,528	0.8
	1976	787	49.4	806	50.6	1,593	0.9
	1981	811	48.8	852	51.2	1,663	0.9
	1986	837	48.2	898	51.8	1,735	0.7
	1991	859	47.7	940	52.3	1,799	0.6
	1996	877	47.4	974	52.6	1,851	
Case 2.1	FERTILITY MEDIUM, IMMIGRATION LOW						
	1971	769	50.1	765	49.9	1,534	1.1
	1976	799	49.4	818	50.6	1,617	1.3
	1981	841	48.8	881	51.2	1,722	1.3
	1986	890	48.4	949	51.6	1,839	1.2
	1991	937	48.0	1,014	52.0	1,951	1.0
	1996	980	47.8	1,072	52.2	2,052	
Case 3.1	FERTILITY HIGH, IMMIGRATION LOW						
	1971	773	50.2	768	49.8	1,541	1.5
	1976	819	49.5	837	50.5	1,656	2.0
	1981	895	49.0	932	51.0	1,827	2.2
	1986	990	48.6	1,045	51.4	2,035	1.9
	1991	1,084	48.4	1,155	51.6	2,239	1.8
	1996	1,182	48.3	1,266	51.7	2,448	

Table 7.3 (Cont'd.)

Alberta Population Projections by Sex -
Five-year Intervals
at June 1
('000's)

		Male	% Total	Female	% Total	Total	AAGR %
Case 1.2	FERTILITY LOW, IMMIGRATION MEDIUM						
	1971	790	50.7	769	49.3	1,559	1.2
	1976	833	50.4	819	49.6	1,652	1.1
	1981	877	50.2	869	49.8	1,746	1.1
	1986	921	50.0	920	50.0	1,841	0.9
	1991	962	49.9	966	50.1	1,928	0.8
	1996	996	49.8	1,006	50.2	2,002	
Case 2.2	FERTILITY MEDIUM, IMMIGRATION MEDIUM						
	1971	792	50.7	771	49.3	1,563	1.4
	1976	844	50.4	829	49.6	1,673	1.5
	1981	904	50.2	896	49.8	1,800	1.5
	1986	971	50.1	967	49.9	1,938	1.3
	1991	1,034	50.0	1,036	50.0	2,070	1.2
	1996	1,094	49.9	1,099	50.1	2,193	
Case 3.2	FERTILITY HIGH, IMMIGRATION MEDIUM						
	1971	797	50.7	775	49.3	1,572	1.7
	1976	864	50.5	848	49.5	1,712	2.1
	1981	957	50.3	946	49.7	1,903	2.2
	1986	1,067	50.2	1,059	49.8	2,126	2.0
	1991	1,177	50.1	1,171	49.9	2,348	1.9
	1996	1,289	50.1	1,286	49.9	2,575	

Table 7.3 (Cont'd.)

Alberta Population Projections by Sex -
Five-year Intervals
at June 1
('000's)

		Male	% Total	Female	% Total	Total	AAGR %
Case 1.3	FERTILITY LOW, IMMIGRATION HIGH						
	1971	817	50.7	795	49.3	1,612	
	1976	888	50.4	875	49.6	1,763	1.8
	1981	962	50.2	956	49.8	1,918	1.7
	1986	1,038	50.0	1,039	50.0	2,077	1.6
	1991	1,113	49.8	1,120	50.2	2,233	1.5
	1996	1,183	49.7	1,197	50.3	2,380	1.3
Case 2.3	FERTILITY MEDIUM, IMMIGRATION HIGH						
	1971	819	50.6	798	49.4	1,617	
	1976	900	50.4	886	49.6	1,786	2.0
	1981	993	50.2	985	49.8	1,978	2.1
	1986	1,094	50.0	1,092	50.0	2,186	2.0
	1991	1,195	49.9	1,198	50.1	2,393	1.8
	1996	1,294	49.8	1,303	50.2	2,597	1.6
Case 3.3	FERTILITY HIGH, IMMIGRATION HIGH						
	1971	823	50.6	802	49.4	1,625	
	1976	921	50.4	906	49.6	1,827	2.4
	1981	1,048	50.2	1,038	49.8	2,086	2.7
	1986	1,198	50.1	1,192	49.9	2,390	2.8
	1991	1,351	50.1	1,348	49.9	2,699	2.5
	1996	1,513	50.0	1,512	50.0	3,025	2.3

TABLE 7.4

POPULATION AGE DISTRIBUTIONS
(1966, 1981, 1996)
('000's)

	ACTUAL		CASE 1.1				CASE 2.2				CASE 3.3			
	1966	%	1981	%	1996	%	1981	%	1996	%	1981	%	1996	%
0-4	174	11.9	153	9.2	150	8.1	186	10.3	203	9.3	275	13.2	367	12.1
5-9	180	12.3	141	8.5	155	8.4	163	9.0	204	9.3	215	10.3	347	11.5
10-14	158	10.8	136	8.2	155	8.4	149	8.3	202	9.2	176	8.4	334	11.0
15-19	129	8.8	165	9.9	145	7.8	172	9.6	185	8.4	185	8.9	285	9.4
20-24	102	7.0	174	10.5	136	7.3	178	9.9	161	7.3	188	9.0	223	7.4
25-29	92	6.3	157	9.4	135	7.3	155	8.6	146	6.7	170	8.1	188	6.2
30-34	94	6.4	130	7.8	166	9.0	127	7.1	169	7.7	147	7.0	202	6.7
35-39	95	6.5	98	5.9	168	9.1	100	5.6	174	7.9	121	5.8	206	6.8
40-44	89	6.1	80	4.8	142	7.7	90	5.0	152	6.9	105	5.0	181	6.0
45-49	78	5.3	76	4.6	111	6.0	91	5.1	123	5.6	100	4.8	151	5.0
50-54	67	4.6	76	4.6	79	4.3	91	5.1	95	4.3	96	4.6	120	4.0
55-59	55	3.8	70	4.2	61	3.3	82	4.6	83	3.8	85	4.1	100	3.3
60-64	46	3.1	61	3.7	59	3.2	68	3.8	80	3.6	71	3.4	90	3.0
65-69	35	2.4	51	3.1	58	3.1	55	3.1	74	3.4	57	2.7	79	2.6
70-74	28	1.9	40	2.4	50	2.7	40	2.2	60	2.7	42	2.0	64	2.1
75-79	21	1.4	30	1.8	40	2.2	28	1.6	43	2.0	29	1.4	45	1.5
80-84	13	0.9	18	1.1	27	1.5	17	0.9	27	1.2	18	0.9	29	1.0
85-89	5	0.3	9	0.5	13	0.7	8	0.4	12	0.5	8	0.4	13	0.4
TOTAL	1,461		1,663		1,851		1,800		2,193		2,086		3,025	
15-64		57.9		65.3		65.0		64.1		62.4		60.8		57.7

COLUMNS MAY NOT ADD TO TOTAL DUE TO ROUNDING.

Table 7.5

Sensitivity Analysis
(Population Projection in Thousands)

	1981		1996	
'Standard' Case	2,034		2,776	
		% Change		% Change
Death Rates +50%	1,981	- 2.7	2,671	- 3.8
Death Rates -50%	2,097	+ 3.1	2,902	+ 4.5
Immigration +50%	2,125	+ 4.5	2,986	+ 7.6
Immigration -50%	1,944	- 4.4	2,565	- 7.6
Fertility +50%	2,328	+14.5	3,642	+31.2
Fertility -50%	1,740	-14.5	2,018	-27.3

% Change: Changes are taken as percentage of 'standard'.

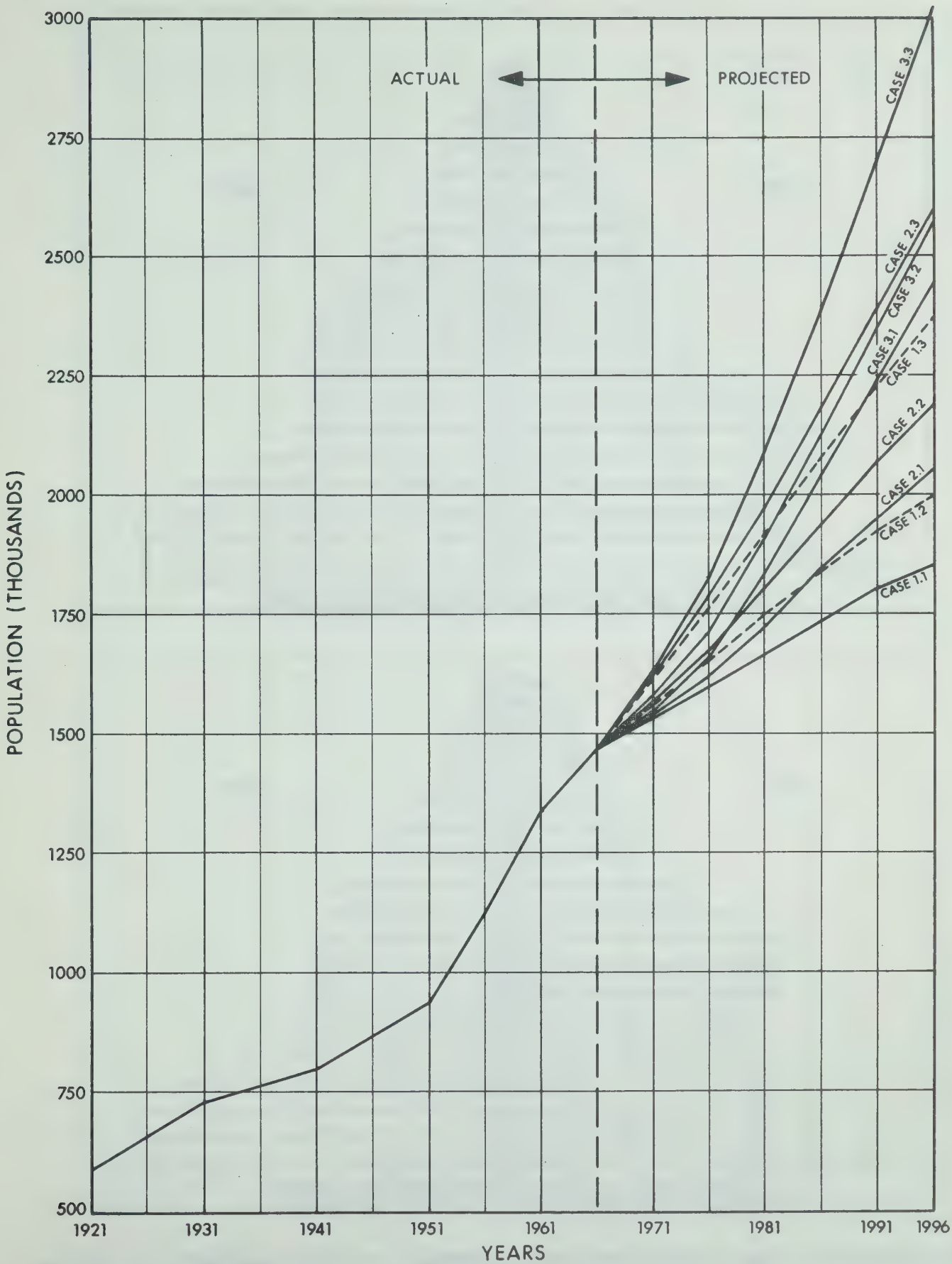
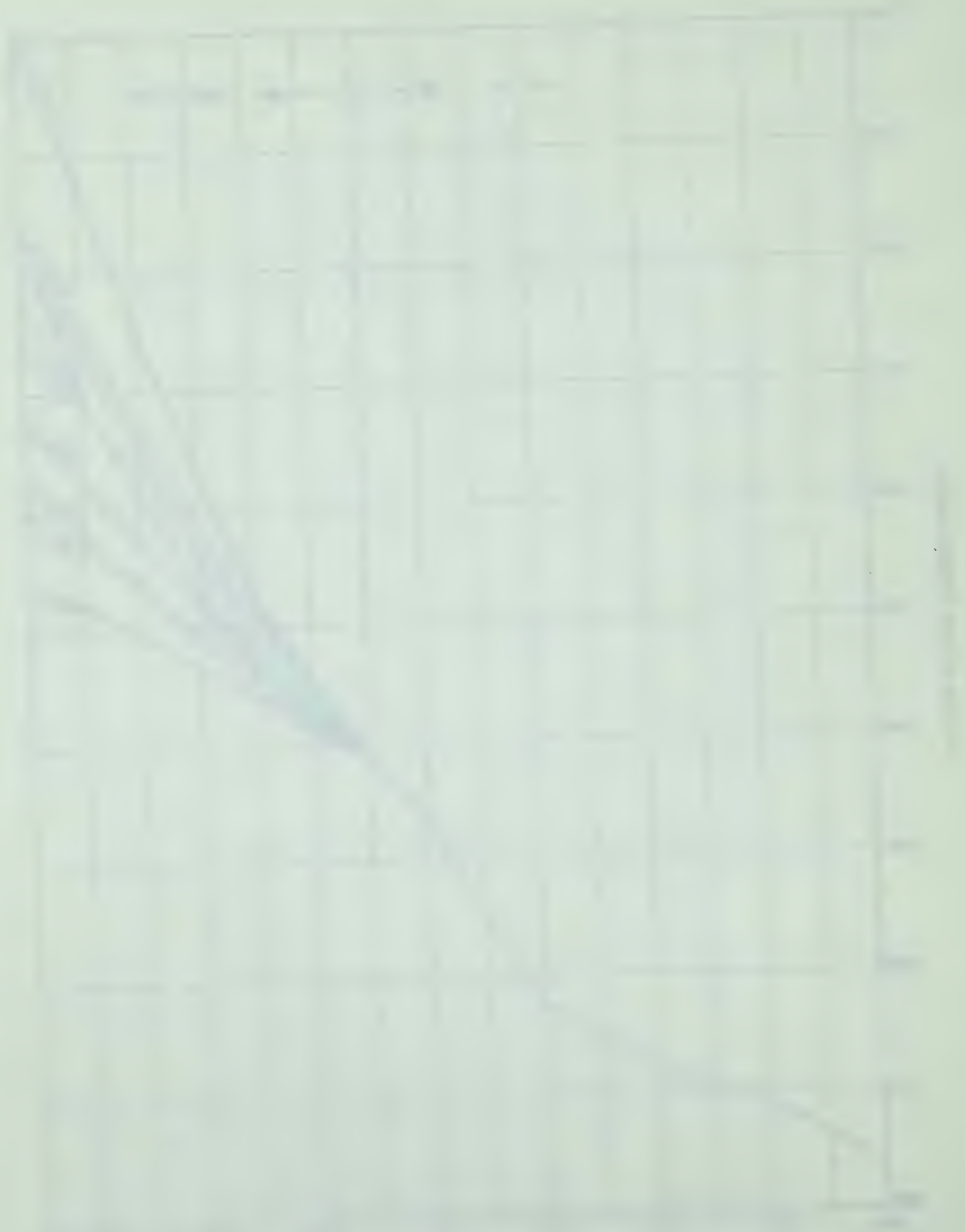


FIGURE 7.1 ALBERTA POPULATION

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA



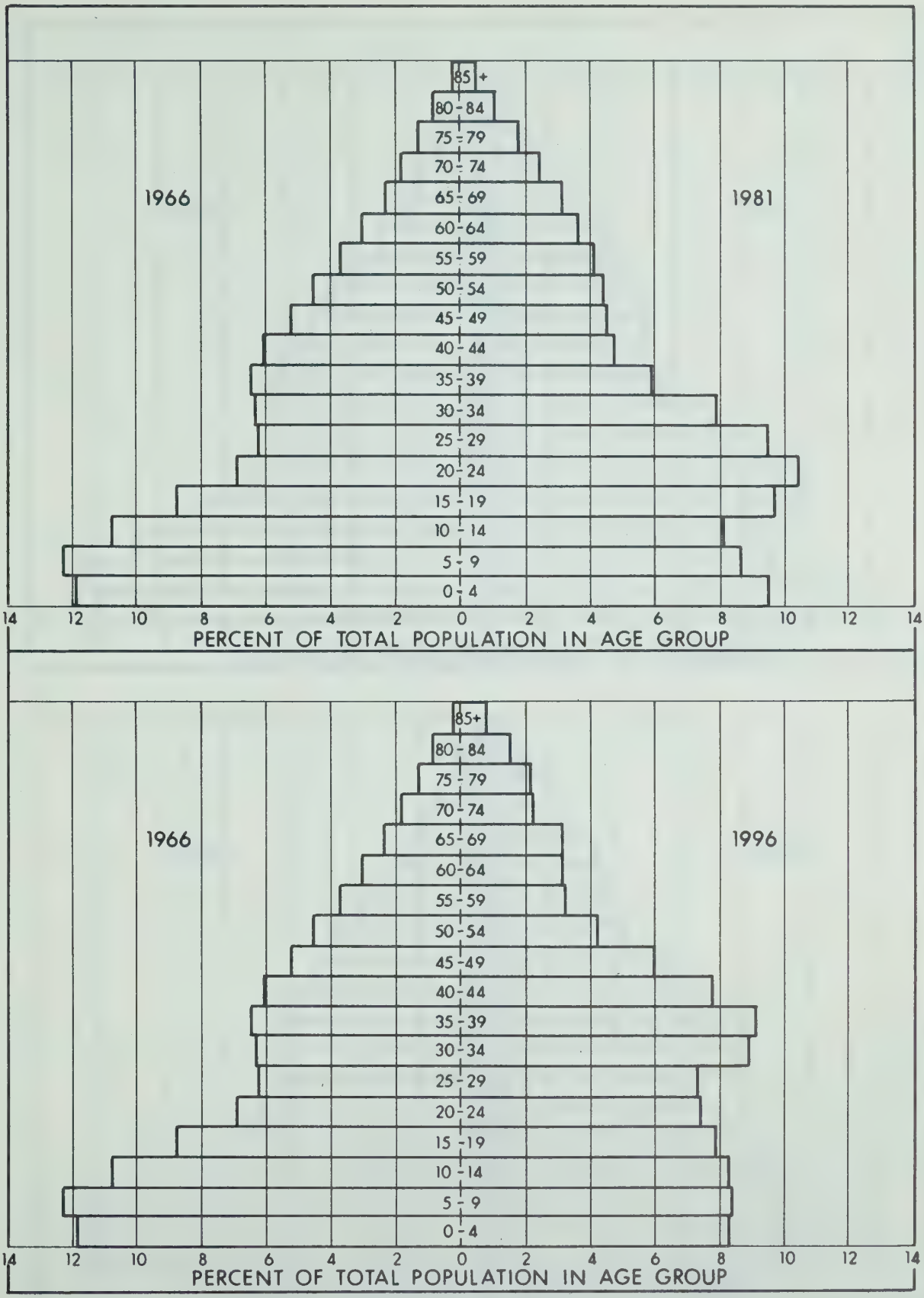


FIGURE 7.2 COMPARISON OF CURRENT AND PROJECTED AGE DISTRIBUTION - CASE 1.1

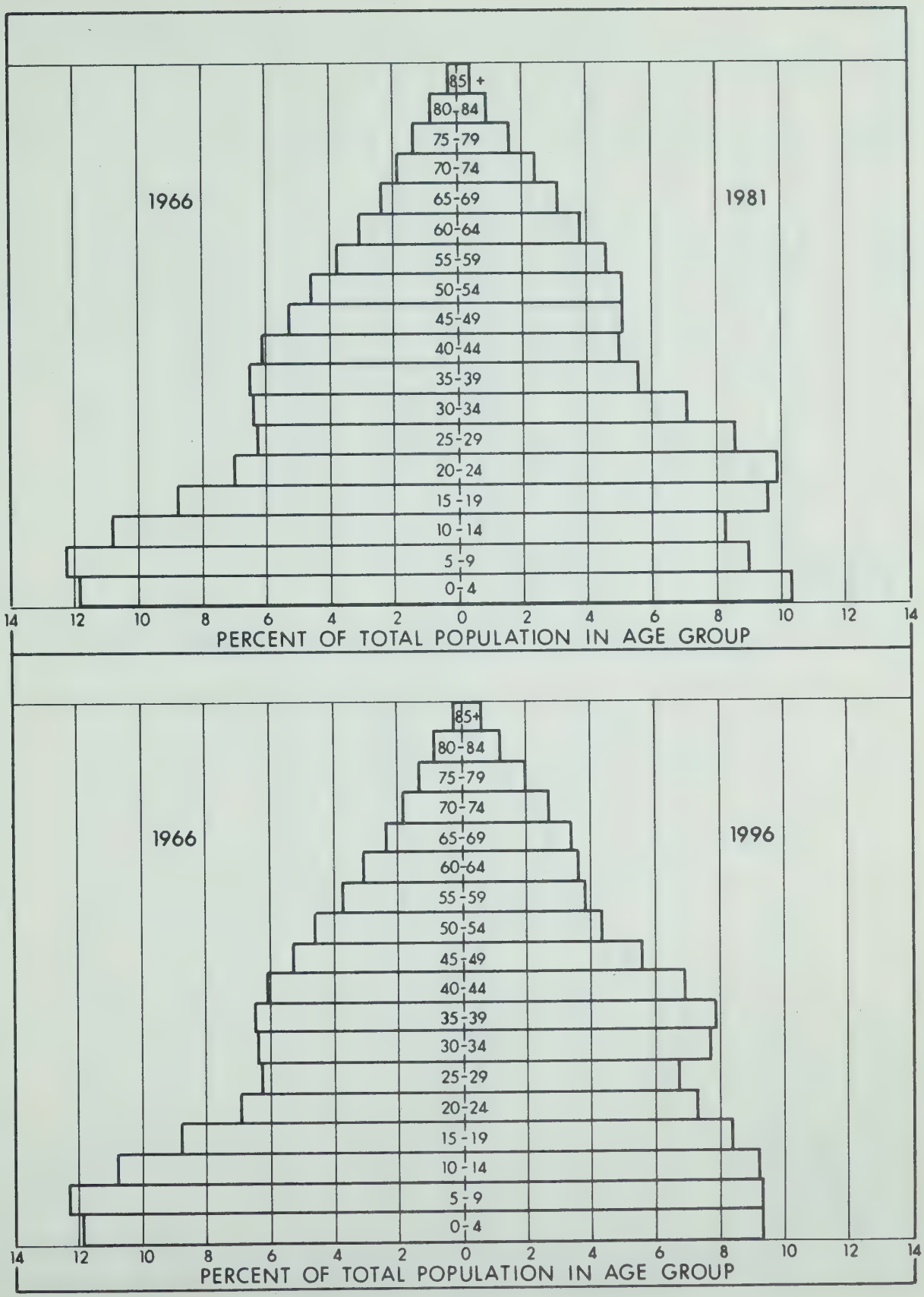


FIGURE 7.3 COMPARISON OF CURRENT AND PROJECTED AGE DISTRIBUTION - CASE 2.2

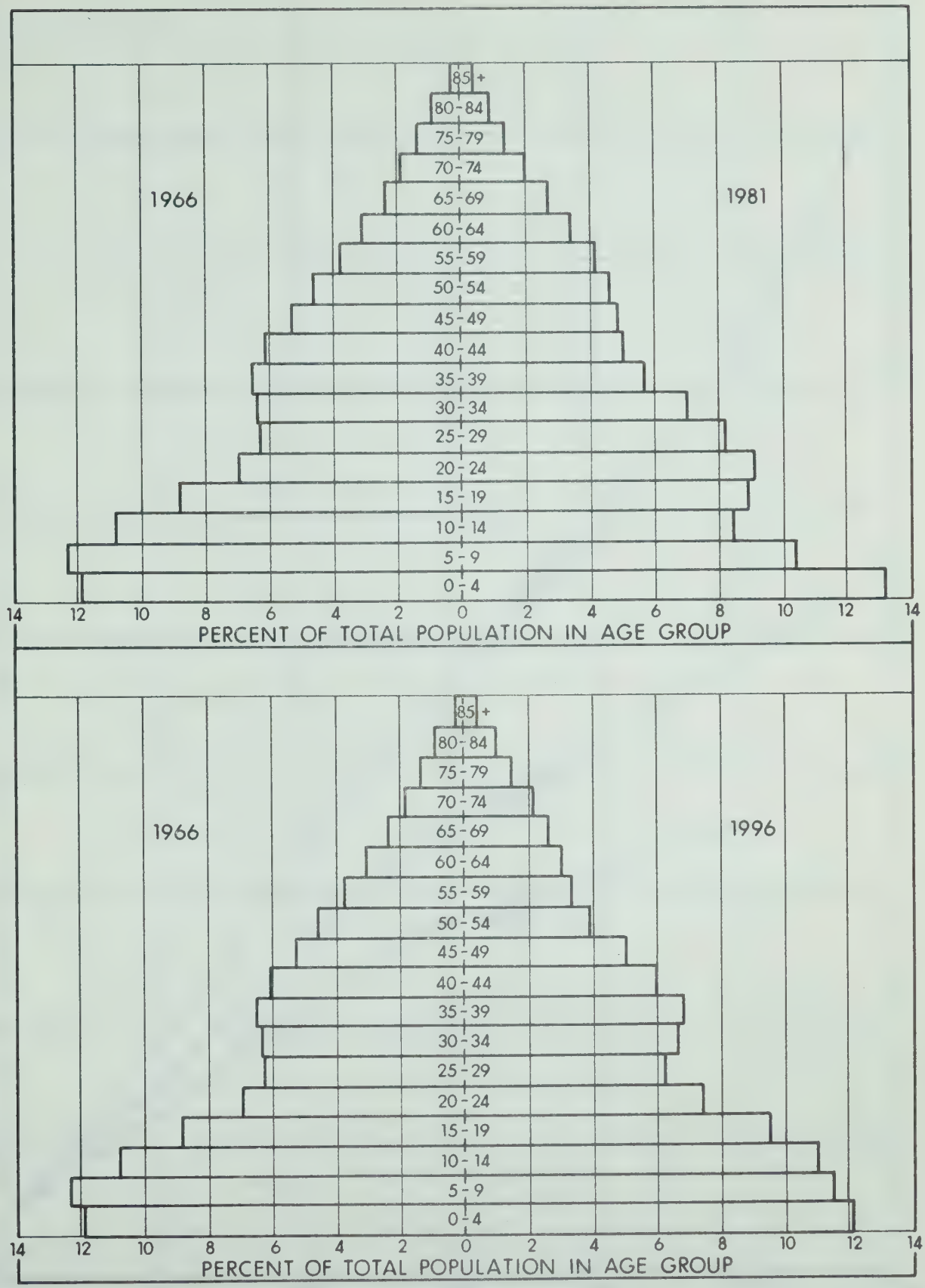


FIGURE 7.4 COMPARISON OF CURRENT AND PROJECTED AGE DISTRIBUTION - CASE 3.3

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

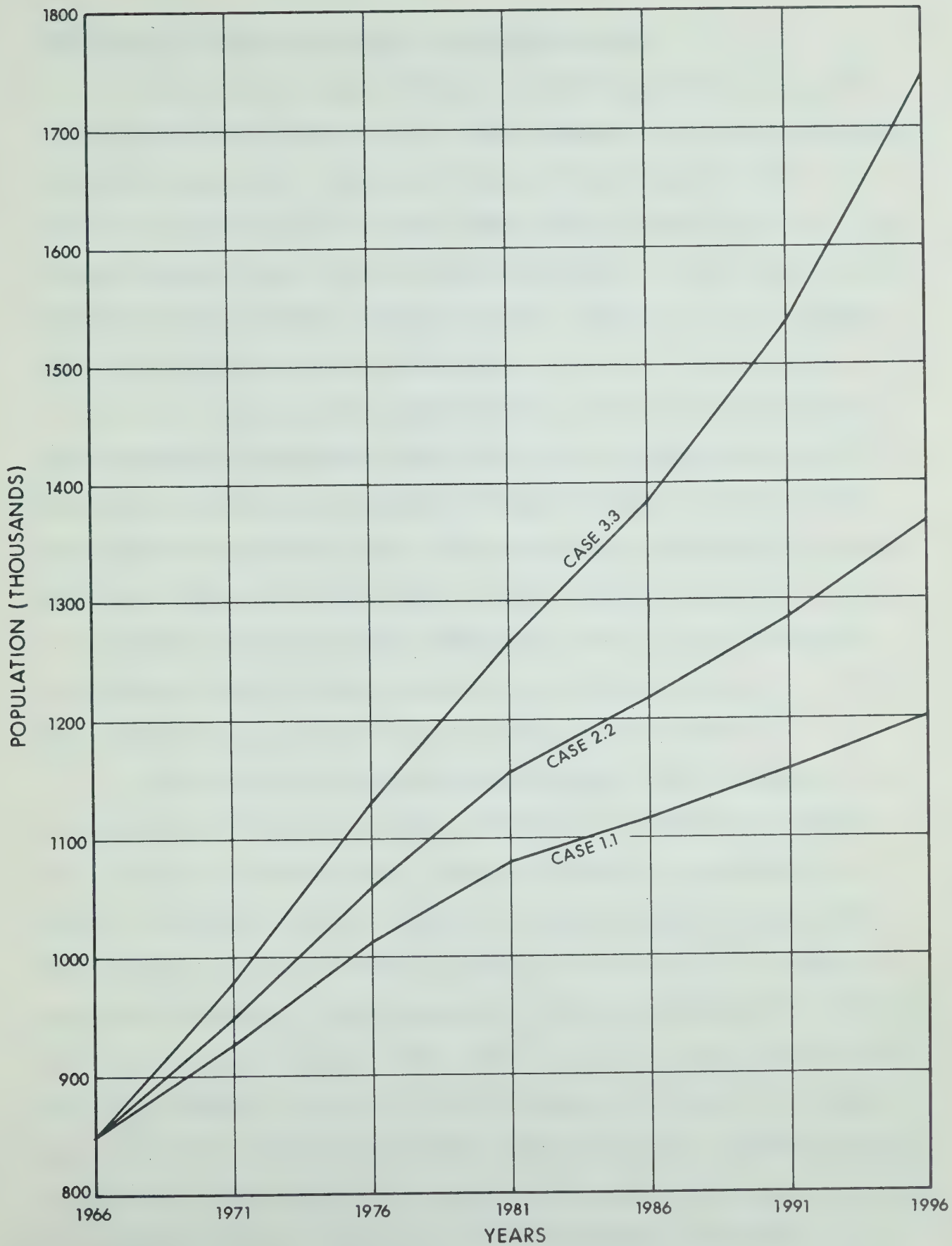


FIGURE 7.5 LABOR FORCE SOURCE POPULATION

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

8. Comparison of Current Projections and Prior Forecasts

8.1 Several earlier forecasts of Alberta population are compared to the projections of Section 7 for 1981 in Table 8.1 and for the years 1966 to 1981 in Figure 8.1. Comparisons were not extended beyond 1981, since this was the latest projection date common to all of the reports. All prior studies forecast a 1981 level of population higher than the Economic Studies Department's (ES) current 'medium' projection, Case 2.2. Two are higher than the ES 'high' projection, Case 3.3.

8.2 The two previous Board forecasts (1959, 1962) were based on an extrapolation of aggregate trends rather than a detailed analysis of the population structure, as also was the forecast prepared in 1967 by the Provincial Planning Branch. The latter projection is approximately linear. The rather high 1959 and 1962 Board forecasts probably reflect the influence of the rapid growth of the years immediately preceding their preparation. In the case of the 1959 Board Forecast, this influence was partially offset by a reduction in growth over the later years of the forecast.

8.3 The British Columbia Research Council (BCRC) in 1963 and the Alberta Bureau of Statistics (ABS) in 1968 both employed methods similar to those used in the current study. The BCRC projection is substantially higher, principally because it projected a continued upward trend in fertility rates; these had not begun to decline significantly at the time the study was undertaken. The ABS projection 'without net migration' - ABS(1) - lies very close to the mean between Cases 1.1 and 3.3 and is less than five per cent in excess of Case 2.2 in 1981. However, the slope of the ABS(1) projection curve becomes progressively greater than that of the ES Case 2.2, a reflection of ABS's adoption of fertility rates which gradually increase from the 1966 level, in contrast to the decline assumed under Case 2.2.

Extrapolation beyond 1981 would accentuate this effect.

8.4 The ABS(1) projection results are remarkably similar to the ES 'high fertility, medium immigration', Case 3.2. As shown in Table 8.2, there is a close comparison between both the aggregate and age group results for 1981. Since neither case involves net migration, this result indicates that the high fertility rates projected for Case 3.2 were in close agreement with the fertility rates adopted by the ABS, assuming the respective estimates of death rates do not differ significantly. The difference between the ABS projection 'with 5,000 net immigration' - ABS(2) - and the ES Case 3.3 appears primarily to reflect the additional immigration of 5,000 persons per year postulated under the latter case. This follows from the previous conclusion that the fertility rate projections are approximately equivalent.

Table 8.1

Comparison of Population Projections to 1981

Date	Source	1981 Projection
1959	Alberta Oil and Gas Conservation Board	1,993,000
1962	Alberta Oil and Gas Conservation Board	2,299,000
1963	British Columbia Research Council(1)	2,362,000
1967	Provincial Planning Branch (Alberta)(2)	1,928,000
1968	Alberta Bureau of Statistics(3)	
	without net migration - ABS(1)	1,886,000
	with 5,000 net immigration - ABS(2)	1,981,000
1968	Present Study	
	Case 1.1 low fertility, low immigration	1,663,000
	Case 2.2 medium fertility, medium immigration	1,800,000
	Case 3.3 high fertility, high immigration	2,086,000

Sources: (1) British Columbia Research Council, 'Population Trends in Canada, British Columbia, Alberta and Saskatchewan 1966 - 1981'. (October 1963).

(2) Provincial Planning Branch. Department of Municipal Affairs, 'Population Trends'. (September, 1967).

(3) Alberta Bureau of Statistics, 'Population Forecast'. (April, 1968).

Table 8.2

Comparison for 1981:
ABS(1) and Board Case 3.2 Projections
(Population in Thousands)

	ABS(1)	Board Case 3.2
0-4	224	250
5-9	192	192
10-14	165	158
15-19	172	172
20-24	178	178
25-29	156	155
30-34	127	127
35-39	100	100
40-44	90	90
45-49	92	91
50-54	91	91
55-59	82	82
60-64	69	68
65-69	54	55
70-74	40	40
75-79	28	28
80-84	16	17
85-89	7	8
90+	3	0
Total	1,886	1,902

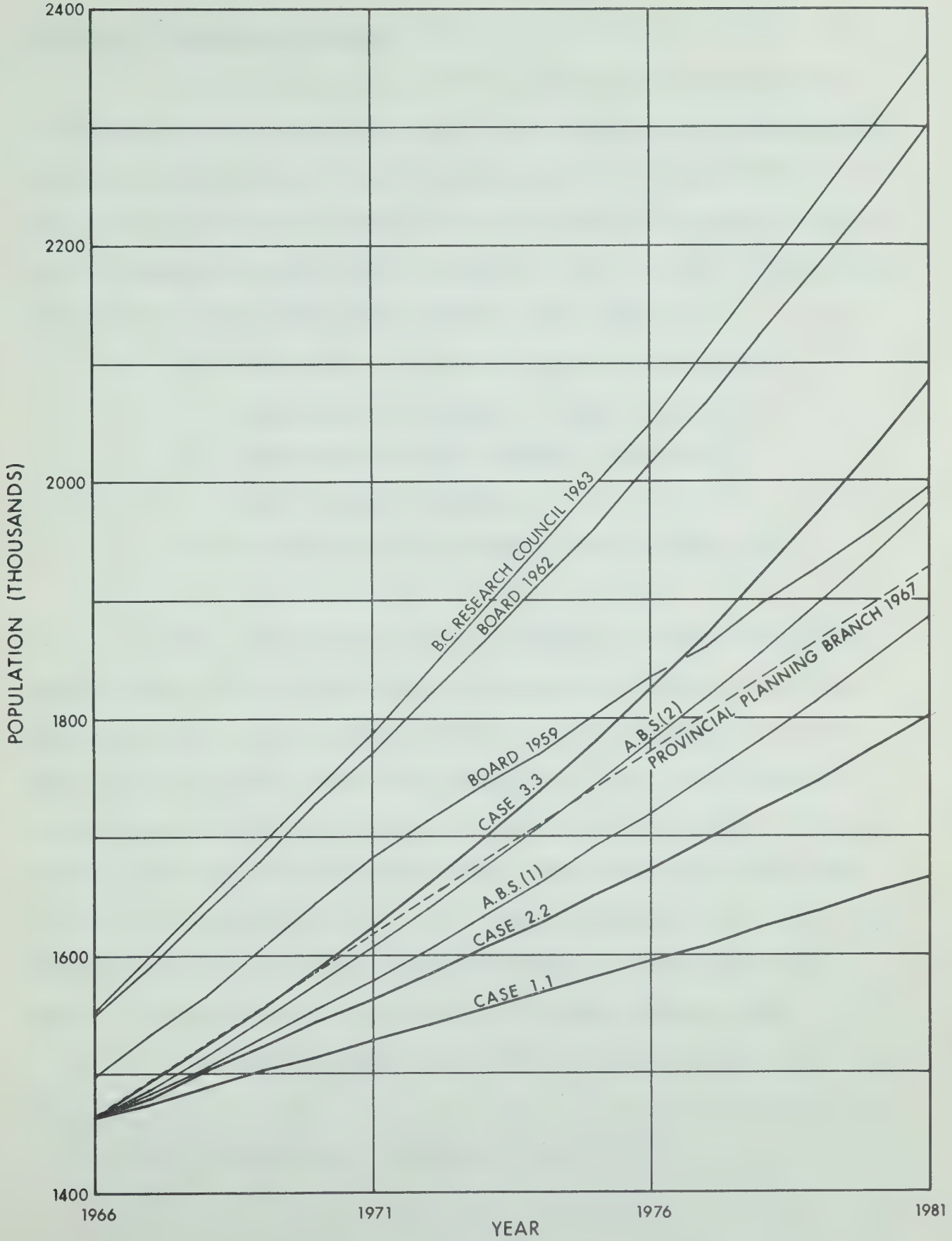


FIGURE 8.1 COMPARISON OF POPULATION PROJECTIONS

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

Appendix A Computational Method*

1. Several difficulties arise in applying the simple procedure of Section 3 to actual population data. One problem is the conversion to discrete annual estimates of what is essentially a continuous process. Another is the necessity to use data for births, deaths and population which relate to time periods that do not coincide. In the treatment of these problems, the following simplifying assumptions were made:

(a) The number of births and deaths is distributed uniformly over any given 12 month interval.

(b) Females are fertile from their fifteenth to their fiftieth birthdays.

(c) No member of the population survives beyond age 89.

2. The different time periods for which data are available are shown in Chart A1. This chart should be perused in conjunction with the discussion below. The calculation of population distributions by sex and single years of age for females is illustrated in Chart A2, columns 1-3, for the census date of June 1 each year. Since births and deaths for each 12 month period are assumed to be uniformly distributed, the average age on June 1 of the group aged 'j-1' to 'j' may be presumed to be 'j-$\frac{1}{2}$'. The average birthday for all groups is thus December 1: six months after June 1. For computational simplicity, it was further assumed that:

(d) the whole population was born on November 30/

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* The actual programmes are documented in Appendix B.

December 1. That is, all births are treated as occurring on this date.

Accordingly, the group aged 'j-1' to 'j' on June 1, year 't-1' becomes 'j' years old on December 1, year 't-1', and constitutes the group aged 'j to j+1' for the June 1, year 't' census. For purposes of exposition, the age groups will be referred to by their lower limit. Thus, the age group 'j-1' to 'j' will be designated by the lower age, 'j-1', on June 1, year 't-1'. All in this group become 'j' years old on December 1 and are designated as group 'j' for the June 1, year 't' census.

3. While the population census 'year' is from June 1 to May 31, the statistics relevant to births and deaths are compiled for the calendar year. To adjust the calendar year data to the census year, it is necessary to calculate births and deaths for three periods: June 1 to November 30 (six months or $\frac{1}{2}$ year); December 1 to 31 (one month or 1/12 year); January 1 to May 31 (five months of 5/12 year). The December 1 split is necessary to reflect the prior assumption that all groups change age at this point.

4. Survivors on June 1, year 't' are estimated as shown in column 4 of Chart A2 by applying to the population on June 1, year 't-1' one-half of the calendar year 't-1' death rate for age 'j-1', one-twelfth of the calendar year 't-1' death rate for age 'j' and five-twelfths of the calendar year 't' death rate for age 'j'.

5. Live births are estimated in column 6 of Chart A2. Births from June 1 to November 30 are calculated by applying one-half of the calendar year 't-1' fertility rate for age 'j-1' to the group population at the mid-point of the interval, September 1, the latter population being obtained by applying one-quarter of the calendar year 't-1' death rate for age 'j-1'

to the June 1 population. Births for December 1 to May 31 are similarly calculated by applying one-twelfth of the calendar year 't-1' fertility rate for age 'j' and five-twelfths of the calendar year 't' fertility rate for age 'j' to the group population at March 1, with the latter population being obtained by applying one-half of the calendar year 't-1' death rate for age 'j-1', one-twelfth of the calendar year 't-1' death rate for age 'j' and one-sixth of the calendar year 't' death rate for age 'j' to the June 1 population. Given assumption (b) preceding, fertility rates are zero for ages 14 and below, 50 and above. This implies that female group '15' on June 1, 't', will have borne children only after December 1, year 't-1', whereas female group '50' on June 1, year 't', will have borne children only before December 1, year 't-1'.

6. All birth cohorts calculated for September 1 and March 1 are centered by assumption (d) on December 1 and thus constitute the '0-1' group, designated age '0' at that date. Births are divided into male and female by application of the male-female birth ratio. The population of the female age group '0' on June 1, year 't', is estimated in column 7 of Chart A2 by applying one-twelfth of the calendar year 't-1' and five-twelfths of the calendar year 't' death rate for age '0' to the estimated annual female births. This method overstates the population aged '0-1' at June 1, year 't', since roughly two-thirds of infant deaths occur within one month of birth. However, the approximate magnitude of the error is 250* out of a

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* error = $\left[(2/3 - 1/12)\ (\text{year 't-1' rate}) - (5/12 - (5/11)(1/3))\ (\text{year 't' rate})\right]$ (annual births).

If the year 't-1' and 't' rates were the same, the 1965 error =
(.318) (infant death rate) (annual births)
= (.318) (785) = 250.

total of 33,000 males and females aged '0-1' and is not significant when appraised in terms of the accuracy of the data and of the model. Moreover, the error is not cumulative, since '0-1' deaths will be overestimated during the six months subsequent to June 1 to the same extent as they were understated during the previous six months, provided that there is no significant difference between '0-1' death rates in years 't-1' and 't'. Thus, the population of age groups '1-2' and upwards is unlikely to be affected.

7. The model used is represented below in terms of matrices.* The outline is confined to the treatment of native born females. The model was logically extended to include males and migrants in the actual programmes described in Appendix B.

The following notation was adopted:

w_{tj} = females aged 'j' on June 1, year 't'

d_{tj} = calendar year 't' death rates for females aged 'j'

f_{tj} = calendar year 't' fertility rates for females aged 'j'

where subscript 'j' designates the lower age limit of each age group,

x_t = fraction of total live births over the census year June 1, 't-1', to June 1, 't', which were females.**

n = age beyond which there are no survivors; that is

$w_{t,n+1} = 0$.

The model assumes $n = 89$; and $f_{t,j} = 0$ for $j = 1,\ldots,14; 50,\ldots,n$.

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* See Lewis, E.G., 'On Generation and Growth of a Population', Sankhya, Vol. 6 (1942), pp. 93-96.

** $$x_t = \left[(7/12)\left(\frac{1000}{1000 + r_{t-1}}\right) + (5/12)\left(\frac{1000}{1000 + r_t}\right)\right]$$

where r_t is the number of live male births per 1000 live female births in year 't'.

W_t = the age distribution vector for females in year 't', centered as at June 1st.

D_t, F_t = the death and fertility rate matrices for females in year 't', on a calendar year basis.

C = a transformation matrix to accommodate the assumed age change on December 1

I = identity matrix

Then: $$W_t = S_4 W_{t-1} + s_5 x_t \left[\tfrac{1}{2}F_{t-1} S_1 + \left[1/12F_{t-1} + 5/12F_t\right] S_3 \right] W_{t-1}$$

where $$S_1 = \left[I - \tfrac{1}{4}D_{t-1} \right]$$

$$S_3 = \left[I - \tfrac{1}{2}D_{t-1} - 1/12 \left[D_{t-1}\, C\right] - 1/6 \left[D_t\, C\right] \right]$$

$$S_4 = \left[I - \tfrac{1}{2}D_{t-1} - 1/12 \left[D_{t-1}\, C\right] - 5/12 \left[D_t\, C\right] \right]$$

$$s_5 = (1 - (1/12)d_{t-1,0} - (5/12)d_{t0})$$

and

$$W_t = \begin{bmatrix} w_{t0} \\ w_{t1} \\ \cdot \\ \cdot \\ \cdot \\ w_{t,n-1} \\ w_{tn} \end{bmatrix} \quad D_t = \begin{bmatrix} d_{t0} & \cdots & 0 & 0 \\ 0 & \cdots & 0 & 0 \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ 0 & \cdots & d_{t,n-1} & 0 \\ 0 & \cdots & 0 & d_{tn} \end{bmatrix} F_t = \begin{bmatrix} f_{t0} & \cdots & f_{t,n-1} & f_{tn} \\ 0 & \cdots & 0 & 0 \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ 0 & \cdots & 0 & 0 \\ 0 & \cdots & 0 & 0 \end{bmatrix}$$

$$C = \begin{bmatrix} 0 & \cdots & 0 & 0 \\ 1 & \cdots & 0 & 0 \\ 0 & 1 & \cdots & 0 & 0 \\ \cdot & & & \cdot & \cdot \\ \cdot & & & \cdot & \cdot \\ 0 & \cdots & 0 & 0 \\ 0 & \cdots & 1 & 0 \end{bmatrix} \quad D_tC = \begin{bmatrix} 0 & \cdots & 0 & 0 \\ d_{t1} & \cdots & 0 & 0 \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ 0 & \cdots & 0 & 0 \\ 0 & \cdots & d_{tn} & 0 \end{bmatrix} \quad F_tC = \begin{bmatrix} f_{t1} & \cdots & f_{tn} & 0 \\ 0 & \cdots & 0 & 0 \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ \cdot & & \cdot & \cdot \\ 0 & \cdots & 0 & 0 \\ 0 & \cdots & 0 & 0 \end{bmatrix}$$

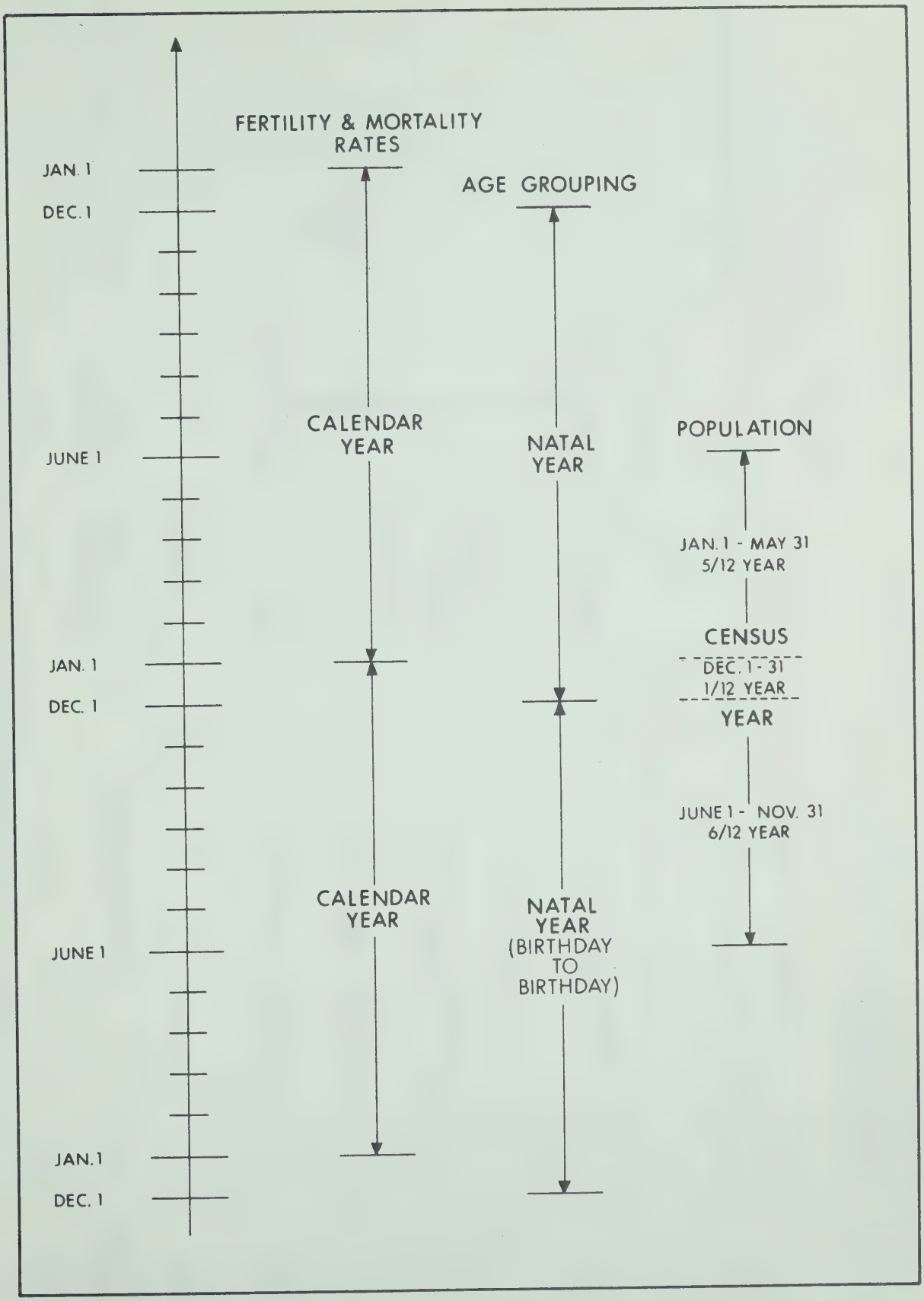

CHART A.1 POPULATION DATA PERIODS

OIL AND GAS CONSERVATION BOARD
CALGARY, ALBERTA

Chart A2

Computational Procedure for Generating Female Population

(1) Date	(2) Female Age Group	(3) Age of Group	(4) Group Population	(5) Appropriate Birth Rate	(6) Births to Group 'j'	(7) Population of Group 'j=0'
June 1 't-1'	j-1	$j-\frac{1}{2}$	$w_{t-1,j-1}$			
Sept.1	j-1		$w_{t-1,j-1}(1-\frac{1}{4}d_{t-1,j-1})=a$	$\frac{1}{2}f_{t-1,j-1}$	$(\frac{1}{2}f_{t-1,j-1})\ a$	
Dec. 1	j	j	$w_{t-1,j-1}(1-\frac{1}{2}d_{t-1,j-1})$		B_j	$x_t \sum_{j=15}^{50} B_j$
Jan.1	j		$w_{t-1,j-1}(1-\frac{1}{2}d_{t-1,j-1}-$ .. .. $1/12d_{t-1,j})$	$1/12f_{t-1,j}$		
Mar.1	j		$w_{t-1,j-1}(1-\frac{1}{2}d_{t-1,j-1}-$ .. .. $1/12d_{t-1,j}-1/6d_{t,j})=b$	$5/12f_{t,j}$	$(1/12\,f_{t-1,j}+$.. ..$5/12f_{t,j})\ b$	
May 31 't'	j	$j+\frac{1}{2}$	$w_{t-1,j-1}(1-\frac{1}{2}d_{t-1,j-1}-$ .. .. $1/12d_{t-1,j}-5/12d_{t,j}$			$x_t \sum_{j=15}^{50} B_j(1-1/12d_{t-1,0}-5/12d_{t,0})$

Definitions:
- 'j' denotes age group 'j' to 'j+1'
- w_{tj} = females aged 'j' on June 1, year 't'
- d_{tj} = calendar year 't' death rates for females aged 'j'
- f_{tj} = calendar year 't' fertility rates for females aged 'j'
- B_j = births to group designated j on June 1/'t'
- x_t = ratio of female births to total births over the census year June 1, 't-1', to June 1, 't'

Appendix B Computer Programmes

1. Three computer programmes were utilized: two to estimate historical net migration and the third to project population. Two programmes were required in the former category in order to circumvent limitations imposed by the data.*

Estimation of Net Migration

2. Programme Name: MIGAGG.

Description: Programme to estimate net migration by sex for up to 25 separate areas.

Data Input: Annual recorded deaths and live births by sex and area; census populations by sex and area.

Output: Intercensal actual and 'natural' increases in population and estimated net migration by sex for the areas concerned.

Data and Method: (i) Provincial deaths and births are recorded by Province of occurrence and Province of residence of the deceased and mother, respectively. The use of data classified on a residential basis is preferable insofar as it eliminates distortions due to temporary movements of population.

(ii) The period over which annual deaths and births are recorded is the calendar year, whereas census enumerations relate to June 1. In calculating the natural increase, it was assumed that the monthly occurrence of deaths and births in a given year was constant. Thus, respective deductions of 5/12 and 7/12 are made in the programme from recorded births and deaths in the beginning and end years of each intercensal interval.

(iii) Before 1956 recorded deaths for Alberta

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* See Section 6, paragraphs 6.4 and 6.5.

were available only by sex. The method of calculating the natural increase employed in MIGAGG does not permit the estimation of age-specific migration flows.

3. Programme Name: MIGRAT

Description: Programme to estimate net migration by sex and single years of age for a single area. The main programme contains an option to utilize two subprogrammes: CONVER and SPRGUE. The subprogrammes permit employment of Sprague multipliers* to distribute data originally classified by 5-year age groups over single years of age. The subprogramme is suitable for use with data in the form of rates or absolute numbers.

Data Input: The programme is designed to permit a wide choice with respect to the form of data input. Fertility rates may be classified according to five-year age groups or single years of age, as may data relating to successive census populations and annual death or survival rates. The number of male per 1,000 female live births is input annually.

Output: The following form of output is associated with all combinations of input: (i) the area's actual census population by sex and single years of age at the end of each intercensal interval;

(ii) the area's estimated population by sex and single years of age, at the end of each intercensal interval, based on the estimated 'natural' increase during the interval, with the latter computed by the application of fertility and death rates;

(iii) the area's estimated provincial net migration by sex and single years of age during each intercensal interval;

(iv) totals by sex for each five-year age group

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* See A.J. Jaffe, Handbook of Statistical Methods for Demographers, U.S. Department of Commerce, Bureau of the Census. (1951) (pp. 94-108).

in (i) to (iii) preceding.

Data and Method: All calculations concerning the generation of the population based on the 'natural' increase are performed on data classified by sex and single years of age, irrespective of the form in which data are input. It is assumed that the population in each age classification is centered at its mid-point and that all births and deaths occur at November 30/December 1.*

Forecast of Total Provincial Population

Programme Name: POPUL

Description: Programme to project population by sex and single years of age for a single area. Similarly to MIGRAT, the main programme contains an option to utilize the subprogrammes CONVER and SPRGUE.

Data Input: The programme permits a choice similar to MIGRAT with respect to the form in which the following parameters are input: the area's census population in the year prior to the forecast period; the area's projected annual age-specific fertility and death or survival rates. Additional data include the projected number of male per 1,000 female live births and the area's projected net migration. The latter is assumed to occur at the end of the interval to which it relates and may be input either by sex or by sex and five-year age group. If the migration projection is by sex only, an estimate of the proportionate age distribution by five-year age group and sex is required.

The initial parameters are reused annually until new ones are specified. For purposes of sensitivity analysis, numerous sets of projections may be applied to the base population.

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* See discussion in Appendix A, paragraph 2.

Output: The form of output is independent of the form of input and consists of a forecast of the area's population at June 1 by sex and single years of age over a period of up to 30 years. Totals for each five-year age group by sex are also output. It is possible to request output at intervals of five years, or any multiple of five up to 30 years, if desired.

Data and Method: The assumptions and method of Appendix A were used.

Appendix C References

Data Sources		Catalogue	Table
Population:	1921, 1931, 1941, 1951, 1956: 1961 Census	92.542	20
	1958: DBS Bulletin	91.203	-
	1959: DBS Vital Statistics	84.202	S2
	1960: DBS Bulletin	91.203	-
	1961: 1961 Census	92.542	20
	1962-1965: DBS Bulletin	91.203	-
	1966: 1966 Census	92.610,92.611	20,25
Births and Deaths:	DBS Vital Statistics	84.202	S6
Fertility Rates:	DBS Vital Statistics	84.202	B6
Ratio male/female births:	DBS Vital Statistics	84.202	B2
Mortality Rates:	DBS Vital Statistics	84.202	D1,D5

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